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Six Sigma – Could it be the Holy Grail for Quality Improvement in the Canadian Forces?

By Colonel Brian O'Rourke

ABSTRACT

The geopolitical environment is becoming increasingly complex which is placing great demands on individuals to gather information, integrate findings, and take effective actions. Leaders of large organizations such as the Canadian Forces are expected to manage a multitude of complex systems and processes that can malfunction without warning leading to devastating consequences. By analyzing diverse subjects such as healthcare and friendly fire, this paper attempts to identify the need for continuous improvement in the quality of all aspects of military affairs. To provide a systematic approach to quality improvement, this paper demonstrates that the application of a Six Sigma methodology can contribute to the provision of relevant, efficient and effective military services. The paper also argues that Six Sigma may reduce the risk of fratricide. To effectively incorporate Six Sigma as the quality methodology for the Canadian Forces, a structured and gradual approach to implementation, taking into consideration the need to respect change management principles, is recommended.

Six Sigma – Could it be the Holy Grail for Quality Improvement in the Canadian Forces?

By Colonel B.K. O'Rourke

INTRODUCTION

On a peaceful afternoon in April, 2002, four hundred people crowded into a church in the small town of Lancaster, Ontario.[1] They had gathered for the funeral of Sergeant Marc Léger. Sergeant Léger was one of four Canadian soldiers killed in a friendly fire incident in Afghanistan on the night of April 17th, 2002. In his eulogy, Major Shane Schreiber described Sergeant Léger as a soldier and leader of rare skill.[2] He had served his country with pride but died in a tragic case of fratricide.

What happened on that fateful evening when the lives of twelve soldiers and their loved ones were forever changed? The final report of the Canadian Board of Inquiry convened to investigate the incident provided the following factual description.[3] Late on the night of 17/18 April, 2002, a section from A Company, 3rd Battalion, Princess Patricia's Canadian Light Infantry Battle Group, was conducting a live fire exercise at the Tarnak Farm Multi-Purpose Range Complex near Kandahar, Afghanistan. During the

[1] CBC News Online Staff, "*Fallen Canadian Soldiers Laid to Rest*," CBC News; available from http://www.cbc.ca/stories/2002/04/24/soldiers020424
[2] Major Shane Schreiber, "*In Memorium…Sergeant Marc Léger*," National Defence; available from http://www.army.dnd.ca/LFWA_HQ/Eulogies_Leger.htm
[3] General Maurice Baril (Retired), *Tarnak Farm Board of Inquiry: Final Report*, Ottawa, June 19, 2002, ii.

course of their exercise, two American F-16 fighter aircraft mistakenly engaged the section. One of the F-16s released a laser-guided bomb killing Sergeant Léger, Corporal Ainsworth Dyer, Private Nathan Smith, and Private Richard Green, and injuring eight others.[4] Although these are the facts of the case, and the Board of Inquiry provided detailed findings and recommendations, what caused the pilot of the F-16 to make a decision to release the bomb may never be fully understood. Could this incident have been prevented? What steps must be taken to prevent similar tragedies?

The geopolitical environment is becoming increasingly complex. In his book, *The Ingenuity Gap*, Thomas Homer-Dixon contends "the complexity, unpredictability, and pace of events in our world, and the severity of global environmental stress, are soaring."[5] Greater complexity places high demands on individuals to gather information, integrate findings, and take effective actions.[6]

Today's global security environment illustrates the increasing complexity that Homer-Dixon describes. Terrorism, religious extremism, weapons of mass destruction, globalization, climate change, emerging health threats and pandemics, failed and failing states, and diminishing natural resources have the potential to destabilize world order, and impact Canada's national security. The uncertainty and complexity of the threats to Canada, inevitably lead to increasingly complex doctrine, tactics, and technology for the Canadian Forces. Terms such as the revolution in military affairs, asymmetric threats,

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[4] *Ibid*, ii.
[5] Thomas F. Homer-Dixon, *The Ingenuity Gap* (Toronto: Vintage Canada, 2001), 1.
[6] Dietrich Dorner, *The Logic of Failure: Recognizing and Avoiding Errors in Complex Situations*, trans. Rita and Robert Kimber. (New York: Metroploitan Books, 1996), 38.

shock and awe, and network-enabled operations, are becoming commonplace in the military lexicon. However, changes made to any aspect of war fighting or military operations, in an effort to enhance system performance, tend to make the system more complex.[7] This complexity most certainly contributes to the risk of errors and perhaps to the risk of friendly fire.

In order to cope with the complexity and effectively manage the growing threats and technological innovations being introduced to deal with the threats, societies require more ingenuity; however, the necessary ingenuity isn't always available at the right time and place.[8] As a result, organizations are often faced with what Homer-Dixon refers to as an ingenuity gap: "a shortfall between the rising need for ingenuity and the ability to supply the needed ingenuity."[9]

Incidents of friendly fire such as what happened on April 17th, 2004 at Tarnak Farm, are often considered an unfortunate consequence of war. But fratricide should not simply be accepted as an inevitable phenomenon. All militaries need to institute measures to reduce the incidence of fratricide, particularly in light of the complexity of military operations, the geopolitical environment, and the ability of human beings to manage complexity in the world of tomorrow.

The Canadian Forces as an organization relies on people as its most important system. These human systems exist within an overall environmental system that is

[7] Homer-Dixon, *The Ingenuity Gap*, 4.
[8] *Ibid*, 1.

placing ever-increasing demands upon them. If the complexity of these demands exceeds the complexity of the system, then the system will fail.[10] Fratricide serves as a tragic example of a system gone wrong.

Consequently, all aspects of military affairs, from war fighting to logistics, from peace support operations to training, and the many corporate-level activities involved in managing the military machine require constant examination and improvement. This is an essential aspect to the maintenance of relevance and effectiveness, the assurance of quality, and the promotion of stewardship. Indeed, the pressure to provide flawless execution is increasing.[11] For example, the Treasury Board of Canada Secretariat has created a Management Accountability Framework to provide all government departments with a defined set of expectations within an overall framework for high organizational performance.[12]

Care must be taken however, in attempting to correct a broken system. In *The Logic of Failure*, Dietrich Dörner argues that it is incorrect to simply focus on what is wrong and what needs to be corrected.[13] He believes that it is important to assess situations from a systemic viewpoint because a complex system, such as the Canadian Forces or any military force for that matter, is made up of different components that

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[9] *Ibid*, 1.
[10] *Ibid*, 194.
[11] Ronald D. Snee, "Weave Six Sigma Into the Fabric of an Organization," *Quality Progress* 37, no. 9 (Sep 2004): 69-72.
[12] Treasury Board of Canada Secretariat. *TBS Management Accountability Framework*, available from http://www.tbs-sct.gc.ca/maf-crg_e.asp?printable=True.
[13] Dorner, *The Logic of Failure*…, 72.

interact at many different levels.[14] Thus it is usually wise, when correcting a deficiency to consider it within the context of its system. Failure to do this may lead to correcting the symptom but not the underlying cause of the problem. To reduce the risk of fratricide, more needs to be done to analyse and improve the complete systems and processes in place within modern day military forces.

Achieving what is referred to as a breakthrough in quality, to reach the high levels of organizational performance demanded by Treasury Board, is accomplished by using the project approach.[15] Dr. Joseph M. Juran, considered by many as the father of the modern quality movement, has stated, "All improvement takes place project by project, and in no other way," and he stressed that breakthrough improvement is essential for drastically reducing chronic waste, which he refers to as the cost of poor quality.[16]

Six Sigma is a quality improvement methodology that has achieved breakthroughs in quality. It has been used with remarkable success across a wide range of manufacturing industries and service sectors to deliver quality products and services, and reduce the cost of poor quality. Six Sigma can be applied to virtually any process within an organization.[17]

Six Sigma is highly structured and helps organizations focus on developing near-perfect products, processes, and services. The central idea behind Six Sigma is that by

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[14] *Ibid*, 72-77.
[15] Joseph A. De Feo, and Zion Bar-El, "Creating Strategic Change More Efficiently With a New Design for Six Sigma Process," *Journal of Change Management* 3, no. 1 (Aug 2002): 60-80.
[16] *Ibid*, 60-80.

measuring how many defects there are in a given process, steps can be taken to reduce variation and produce a process with close to zero defects.[18] Six Sigma stresses the application of statistical and problem-solving tools and techniques in a systematic fashion to gain knowledge that leads to breakthrough improvements.[19] By following the principles of Six Sigma, organizations undertake the detailed analysis required to determine the root causes of problems – system-by-system, process-by-process.

Six Sigma examines quality as determined by the customer, which is critical because every organization exists to support a customer base.[20] In the business world, satisfying customers beyond their expectations and better than the competition is closely tied to the survival of the enterprise.[21] A similar case could be made for the Canadian Forces. In a democratic society, military forces exist to serve the government and ultimately the citizens of a country. It is the citizens who provide funding for, and who reap the benefits from, an effective and efficient military. If a public organization becomes complacent and provides ineffective or inefficient service, they may be seen as redundant or irrelevant by the "citizen customers." Taxpayers expect sound management of public resources and value for money.[22]

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[17] Steve Jones, "Understanding Six Sigma," *Quality* 43, no. 3 (Mar 2004): 24.
[18] General Electric Publication, What is Six Sigma? The Roadmap to Customer Impact. 19991438-1
[19] Jiju Antony, and Ricardo Banuelas, "Key Ingredients for the Effective Implementation of Six Sigma Program," *Measuring Business Excellence* 6, no. 4 (2002): 20-27.
[20] Loay Sehwail, and Camille DeYong, "Six Sigma in Healthcare," *International Journal of Health Care Quality Assurance* 16, no. 6 (2003): 1-5.
[21] Alan Larson, *Demystifying Six Sigma: A Company-Wide Approach to Continuous Improvement* (New York: AMACOM, 2003), xii.
[22] Treasury Board of Canada Secretariat, *Modern Comptrollership Frequently Asked Questions*, available from http://www.tbs-sct.gc.ca/cmo_mfc/faq_e.asp?printable=True

To maintain relevance and provide an effective and efficient service in support of the government and the citizens of Canada, the Canadian Forces requires a systematic approach to quality improvement. This paper will demonstrate that the application of a Six Sigma approach to quality improvement can significantly contribute to the Canadian Forces efforts to provide a service that is effective, efficient, and relevant. In particular, adopting a Six Sigma approach to military operations and training may help to reduce the risk of fratricide.

SIX SIGMA'S ORIGINS

Electronics giant Motorola is credited with developing the Six Sigma initiative, more as a means of survival rather than an incremental growth initiative. During the 1980s, Motorola was losing ground in every market they served. Customer dissatisfaction and frustration were growing and operating costs were too high, which led to dismal profits.[23] From their customer's perspective, Motorola had a reputation for being arrogant - their systems were not designed for customer satisfaction.[24] Despite the fact that they had several quality programs in place, the quality of their products was awful.[25] Consequently, like many North American companies, they were losing a large portion of their market share to Japanese competitors, who were producing products of much higher quality.

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[23] Larson, *Demystifying Six Sigma*…, 7.
[24] *Ibid*, 8.
[25] Peter S. Pande, Robert P. Neuman, and Roland R. Kavanagh, *The Six Sigma Way: How G.E., Motorola, and Other Top Companies are Honing Their Performance* (New York: McGraw-Hill, 2000), 7.

Motorola's CEO, Bob Galvin, knew that something had to be done to improve the quality of their products and services, so he sent a group of senior managers and executives on a benchmarking tour of Japan to study operating methods and product quality levels.[26] They discovered that Japan had a national program for employee involvement and teaming, focused on improving operations to better serve their customers. They also discovered that the more complicated a product, the higher the opportunities for failure.[27] Motorola's problems were present in all of their business units and product lines. In his book *Demystifying Six Sigma*, Alan Larson, a former divisional quality director at Motorola, states: "Something had to happen, it had to be major, and it had to get positive results quickly."[28] Thus was born the need to create an innovative, systematic methodology for quality improvement. Motorola's leaders established the vision, set the framework, and launched Six Sigma in 1987.[29]

In the initial stages, Motorola was calling its new quality initiative "total quality control," building upon the Japanese language for "total quality management."[30] As they added more methods such as experimental design, reliability estimation and prediction, and multi-variate analysis to its training programs and toolboxes, executives believed they needed a new name to capture this expanded, enhanced initiative - they chose Six Sigma quality.[31]

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[26] Larson, Demystifying Six Sigma…, 8.
[27] *Ibid*, 9.
[28] *Ibid*, 9.
[29] *Ibid*, 9.
[30] A. Blanton Godfrey, Why Six Sigma," Quality Progress 35, no.1 (Jan 2002): 6.
[31] *Ibid*, 6.

Motorola developed Six Sigma primarily to reduce the high costs associated with poor quality at the end of an assembly line as they had calculated that they were spending up to 20 percent of their total revenue, almost $1 billion dollars per year, on correcting poor quality discovered at the time of final inspection.[32] As time passed, and success grew, Motorola used Six Sigma to focus efforts on reducing variation and improving customer satisfaction in all processes, from manufacturing to administrative.[33] From 1987 to 1999, the first 12 years of Six Sigma at Motorola, they had eliminated 99.7% of all in-process defects.[34] Cumulative manufacturing cost savings totalled more than $18 billion, and employee productivity increased 12% annually.[35] Motorola was also cited as the first winner of the Malcolm Baldridge National Quality award in the United States in 1988.[36]

SIX SIGMA SUCCESS STORIES

Although Motorola was credited with "inventing" Six Sigma, its notoriety is more closely linked to the General Electric (G.E.) Company and its former Chief Executive Officer, Jack Welch. During the 1980s, G.E. was experiencing the same quality void that prompted Motorola to develop Six Sigma. Welch had been sceptical of the quality programs that had been the rage in the 1980s as he felt they were too heavy on slogans

[32] Anthony R. Benedetto, "Adapting Manufacturing-Based Six Sigma Methodology to the Service Environment of a Radiology Film Library," *Journal of Healthcare Management* 48, no. 4 (Jul/Aug 2003): 263-280.
[33] Bengt Klefsjo, Hakan Wiklund, and Rick L. Edgeman, "Six Sigma Seen as a Methodology for Total Quality Management," *Measuring Business Excellence* 5, no. 1 (2001): 31-35.
[34] Dennis Sester, "Motorola: A Tradition of Quality," Quality 40, no. 10 (Oct 2001): 30-34.
[35] *Ibid*, 30-34.
[36] Klefsjo, "Six Sigma Seen as a Methodology…," 31-35.

and too light on results.[37] When word of Motorola's success with Six Sigma started to spread, other companies took note. Allied Signal (now called Honeywell), under the direction of Larry Bossidy, a former G.E. Vice-Chairman, was the next major firm to implement a Six Sigma program. Welch heard about Six Sigma from Bossidy and decided to pursue it. Despite some initial reluctance from managers and employees, Welch pursued Six Sigma with a passion. He described Six Sigma as the most ambitious undertaking the company had ever taken on. In an address to his managers in January 1996, Welch stated "quality can change G.E. from one of the great companies to absolutely the greatest company in world business."[38]

Welch believed that efficiencies in business are infinite, a faith grounded in the belief that there are no bounds to human creativity.[39] With this philosophy firmly embedded in his management approach, Six Sigma and Jack Welch were a perfect fit. G.E. launched Six Sigma in 1996, and the company has never looked back.[40] During the first five years of the program, they more than doubled their annual productivity gains and improved operating margins from 14.4% to 18.4%.[41]

There are countless other businesses, large and small, such as Sony, Lockheed-Martin, Polaroid, Texas Instruments, Honda, American Express, Ford, and Lear

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[37] John A. Byrne, "Jack; A Close-Up Look at How America's 1 Manager Runs G.E.," *Business Week* no. 3851 (June 8, 1998): 90.
[38] Jack Welch with John A. Byrne. *Jack: Straight From the Gut* (New York: Warner Books, 2001): 330
[39] Byrne, "Jack; A Close-Up Look…," 90.
[40] Ibid, 90.
[41] Gregory T. Lucier and Sridhar Seshadri, "G.E. Takes Six Sigma Beyond the Bottom Line," *Strategic Finance* 82, no. 11 (May 2001): 41-46.

Corporation who relate similar success stories with the use of Six Sigma quality.[42] A study conducted in 2002 by Greenwich Associates and the Juran Institute, examined in depth the use of Six Sigma at 13 high profile corporate users in the United States, from a wide variety of industries.[43] They found that among the companies studied, Six Sigma programs returned more than double the investment.

But can Six Sigma have an impact on quality and efficiency in non-manufacturing sectors, or in the public service, or the military? In fact, Six Sigma is gaining attention in health care, finance, law, engineering, marketing, and many other fields.[44] The number of sectors where Six Sigma is being applied is growing rapidly. Government organizations are joining manufacturing, financial, informational technology, and healthcare sectors as Six Sigma proponents.[45] Six Sigma has indeed crossed from the manufacturing sector into the service sector. Increased demand for public sector accountability in its use of resources will exert pressure on all governmental agencies to adopt a methodology that produces results like Six Sigma.[46] The Management Framework for the Government of Canada, *Results for Canadians*, certainly exemplifies the need to have a "citizen focus" built into all government departments – one that provides due diligence and value for money in the use of public funds.[47]

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[42] Klefsjo, "Six Sigma Seen as a Methodology…," 31-35.G8
[43] Anonymous, "A Revealing Study of Six Sigma," *Strategic Direction* 19, no. 8 (Jul/Aug 2003): 34-36.
[44] De Feo, "Creating Strategic Change…," 60-80.
[45] Rick L. Edgeman and David I. Bigio, "Six Sigma in Metaphor: Heresy or Holy Writ? *Quality Progress* 37, no. 1 (Jan 2004): 25-30.
[46] *Ibid*, 25-30.
[47] Treasury Board of Canada Secretariat. *Results for Canadians: A Management Framework for the Government of Canada*, 1.

THE FUNDAMENTALS OF SIX SIGMA

To the sceptic, Six Sigma may seem like the latest business fad. Every few years, a new scheme comes along promising to transform an organization. What then is different about Six Sigma that has seemingly raised it to legendary status? First off, Six Sigma is not a business fad tied to a single method or strategy.[48] Most of the underlying concepts contained in the Six Sigma methodology have been around for years. Six Sigma provides a structured approach that builds on many of the most important leadership and management practices of the past century.[49] It helps organizations create a culture that is totally committed to satisfying the customer. It is about providing a structure in which everyone knows what is expected of them.[50] It is about being focused on outcomes that are driven by continuously improving products and services. It is about relevance – of the organization to the employee, and the organization to the customer. By employing the Six Sigma methodology, organizations have garnered tremendous gains in quality, customer satisfaction, productivity, and profit. Six Sigma has transformed the culture and focus of businesses around the world. It has also evoked interest in the not-for-profit arena. Six Sigma is not a fad – it is the evolution of quality improvement methods and practices that have created a revolution in the quality field. Fundamentally, Six Sigma is a methodology for disciplined quality improvement.[51]

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[48] Pande, *The Six Sigma Way*…, 3.
[49] *Ibid*, 3.
[50] Larson, *Demystifying Six Sigma*…, 5.
[51] James M. Lucas, "The Essential Six Sigma," *Quality Progress* 35, no. 1 (Jan 2002): 27-31.

SIX SIGMA DEFINED

There is no one overarching or generally accepted definition for Six Sigma. Mikel Harry, a key developer and proponent of the Six Sigma program at Motorola, has defined Six Sigma as "a disciplined method of using extremely rigorous data gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them."[52] Bill Smith, the Motorola manager who was credited with developing the mathematics of Six Sigma and is often referred to as the father of Six Sigma, defined it in 1989 very simply as "organized common sense."[53] Pande et al, in their seminal textbook that serves as a detailed guide for the application of Six Sigma, provide the most descriptive definition:

> Six Sigma is a comprehensive and flexible system for achieving, sustaining and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.[54]

The premise of Six Sigma is that organizations need consistently higher levels of quality and lower levels of cost and that a disciplined, organized approach will root out the variance, waste and errors that plague operations – it attacks the root causes of problems.[55] In essence, two central aspects describe Six Sigma - customer focus and data

[52] Klefsjo, "Six Sigma Seen as a Methodology…," 31-35.
[53] Larson, *Demystifying Six Sigma*…, 13.
[54] Pande, *The Six Sigma Way*…, xi.
[55] Jones, "Understanding Six Sigma," 24.

driven rigour.[56] It's important for every Six Sigma project to start with two questions: "who is the customer, and what does the customer want?" In order to deliver a quality process, service, or product to a customer, there must be a clear understanding of what the customer is expecting - in other words, what the measurable specification limits are. Anything that falls outside of the specification limits by definition does not meet the customer's expectations and is therefore a defect.[57]

In summary, Six Sigma is a disciplined quality improvement methodology that requires a close understanding of customer needs and a rigorous measurement and statistical analysis process that forces organizations to continually evaluate those aspects that are critical to quality.[58] These are the processes that will have the greatest impact on customer satisfaction and the success of the organization.

SIX SIGMA STATISTICS

Dr. W. Edwards Deming, who came to prominence as the American statistician who helped Japan become the world leader in manufacturing, is probably the best known quality improvement guru. Dr. Deming stressed the need for providing high quality in every task and he stressed that quality is not cost but yield.[59] Six Sigma provides an effective and disciplined deployment process for many of Deming's teachings,

[56] Erik Einset and Julie Marzano, "Six Sigma Demystified: How it Works for G.E. and How it can Work for You," *Tooling and Production* 68, no. 4 (Apr 2002): 43-47.
[57] *Ibid*, 43-47.
[58] Jones, "Understanding Six Sigma," 24.
[59] Gerald J. Hahn, "Deming and the Proactive Statistician," *The American Statistician* 56, no. 4 (Nov 2002): 290-98.

particularly the significant focus on statistical analysis.[60] For example, an understanding of variation is an important aspect for successful implementation of a Six Sigma program and is a key feature of the Deming philosophy.[61]

Although Motorola coined the name Six Sigma, it is actually a term that has its roots in statistics, specifically from the statistics of the Gaussian or normal distribution. Sigma is the 18th letter of the Greek alphabet and is used to denote standard deviation, or the amount of variation in a product or service. In Six Sigma statistics, quality is rated on a numerical scale that corresponds to the amount of variation in a process. The higher the Sigma level, the lower the defect rate.

Stated in terms of the normal distribution curve, it is known that many observable phenomena can be graphically represented as a bell-shaped curve.[62] The interval created by the mean plus or minus two standard deviations (Two Sigma) contains 95.44% of the data in a normal distribution, whereas the interval created by the mean plus or minus six standard deviations (Six Sigma) contains 99.9999998% of the data in a normal distribution.[63] For most people, this statistical representation can be somewhat confusing. An easier method is to calculate the defect rate as a simple percentage (number of defects or errors divided by the total number of products made or transactions carried out). In Six Sigma jargon, the term yield is also used. Yield refers to the proportion of units produced,

[60] Ibid, 290-98.
[61] Klefsjo, "Six Sigma Seen as a Methodology…," 31-35.
[62] Mark Friedman and Howard Gitlow, "Six Sigma Primer for CPAs," *The CPA Journal* 72, no. 11 (Nov 2002): 56-59.
[63] *Ibid*, 26-29.

or transactions made, that were free of defects.[64] For example a defect rate of 20% is equivalent to a yield of 80%. Once you have calculated the defect rate or the yield, the sigma level can then be determined by using an established conversion chart.

A Six Sigma level represents a miniscule 3.4 defects per million opportunities for making a defect. This is essentially an error free product or service, keeping in mind that in Six Sigma, a defect rate is a measure of the frequency that an event does not meet the customer's expectations.[65] By contrast, Sigma levels of one, two, three, four, and five produce defects per million opportunity rates of 691500, 308500, 66807, 6210, and 233 respectively.[66]

METHODOLOGY AND TOOLS

While measuring quality is the cornerstone of the Six Sigma approach, it's the methodology and tools driving process change that translate the difference between a simple quality campaign slogan and a rigorous management philosophy.[67] Six Sigma provides a systematic approach to validate data and to focus on the critical few inputs that will have the greatest potential to achieve meaningful improvement.[68]

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[64] Pande, *The Six Sigma Way*…, 321.
[65] Forrest W. Bregfoyle III and Becki Meadows, "Bottom-Line Success with Six Sigma," *Quality Progress* 34, no. 5 (May 2001): 101-104.
[66] Klefsjo, "Six Sigma Seen as a Methodology…," 31-35.
[67] Lucier, "G.E. Takes Six Sigma…," 41-46.
[68] Ian R. Lazarus, "Six Sigma Relies on Consumer Data to Set Acceptable Performance Standards," Managed healthcare Executive (Jan 2003): 1-3.

As a quality methodology, Six Sigma should begin and end with the customer. The first step is to determine what is important to the customer by identifying the factors and processes that are critical to quality.[69] It is also important to understand that every process has variation – it's unavoidable. The key is measuring the variation, understanding what factors impact the variation, controlling these factors and communicating all this information broadly so that everyone can understand how to control the process and eliminate defects.[70] This is where the Six Sigma methodology, and the various statistical tools, proves beneficial.

The tools and methods within Six Sigma are designed to organize problem-solving efforts and achieve measurable results.[71] Although originally developed for complex manufacturing processes, they have been successfully adapted for use on all types of process improvement projects.[72]

At the heart of the Six Sigma approach is a method summarized by the acronym DMAIC which refers to define, measure, analyse, improve, and control.[73]

Define

[69] Ricardo banuelas Coronado and Jiju Antony, "Critical Suxxess Factors for the Successful Implementation of Six Sigma Projects in Organizations," The TQM Magazine 14, no. 2 (2002): 273-74.
[70] Einset, "Six Sigma Demystified…," 43-47
[71] Walter H. Ettinger, "The Art and Science of Winning Physician Support for Six Sigma Change," *The Physician Executive* (Sep-Oct 2003): 34-38.
[72] Joshua Mutize, "Six Sigma," AACE International Transactions (2003): R1171.
[73] There are two other variations to the Six Sigma process – DMADV (define, measure, analyse, design, verify) and DFSS (design for Six Sigma). Both of these versions are similar in approach to DMAIC and utilize many of the same processes and tools. DFSS is normally used to prevent and predict defects when designing a product, service or process. All three models can be used effectively, but in this paper, the

The starting point for a Six Sigma project is to clearly define the problem at hand. This involves teamwork to ascertain whether the problems identified are critical to quality, how they might be solved, and what resources will be required.[74] The define phase sets the tone for the entire Six Sigma project by establishing a charter, the team composition and creating clear and measurable goals for success.[75]

Measure

During this stage, there needs to be a baseline measurement of defects and a determination of the customer expectations – what are the specification limits, and how much variation will be tolerated.[76] The use of statistical methods and automated tools helps to develop a measurable understanding of the current process and the scope of the defect.

Analyze

This phase involves determining the underlying reasons for defects.[77] The team uses experiments, simulation, and statistical analysis to identify potential root causes of the defects or the sources of variation.[78] In the analyze phase, the design team uses various

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focus will be on the DMAIC version as it is the original version and the process still used by most Six Sigma organizations.
[74]Anonymous, "G.E. Promotes Six Sigma," Strategic Direction 17, no. 10 (Oct 2001): 17-18.
[75] De Feo, "Creating Strategic Change…," 60-80.
[76] Anonymous, "G.E. Promotes Six Sigma." 17-18.
[77] Lucier, "G.E. Takes Six Sigma…," 41-46.
[78] Mutize, "Six Sigma," R1171.

tools to develop several high level options for an improved design, and then selects one of the designs for implementation.[79]

Improve

During this phase, decisions are made regarding optimal solutions and methods of testing the new design in order to eliminate the previously identified root cause(s) of the problem.[80] The goal is to reduce the variation and demonstrate with data that the problem is solved and leads to a measurable improvement.[81]

Control

This involves on-going monitoring and implementation of measures to ensure that the problem does not recur.[82] Methods used to hold the gains include developing standard operating procedures and instituting statistical process controls.[83] This phase is typically missing from many of the other quality improvement methodologies.[84]

Throughout the DMAIC cycle, there are a number of different tools that can be used in Six Sigma projects – most of which use some form of statistical thinking and analysis. Some of the tools used include: process maps, cause and effect matrices, failure

[79] De Feo, "Creating Strategic Change…," 60-80.
[80] Anonymous, "G.E. Promotes Six Sigma," 17-18.
[81] Mutize, "Six Sigma," R1171.
[82] Anonymous, "G.E. Promotes Six Sigma," 17-18.
[83] Mutize, "Six Sigma," R1171.
[84] Lucier, "G.E. takes Six Sigma…," 41-46.

mode and effects analysis, measurement system analysis, process capability studies, multi-vari studies, design of experiments, Pareto charts, process control plans, and numerous statistical measures.[85]

Six Sigma's goal is to control variation resulting in the near elimination of defects from any process, product or service – far beyond where virtually all organizations are currently operating.[86] Through application of this structured methodology, processes are more completely understood with the assumption that the entire process will be improved by reducing the variation of multiple elements.[87] Organizations may never reach the Six Sigma level of perfection, but a key tenet underlying the philosophy of Six Sigma is progress – not perfection.[88]

SIX SIGMA HIERARCHY SYSTEM

In the Six Sigma approach, responsibility and authority are distributed in a structured way by using a "belt" to identify experience and mastery of Six Sigma tools and their application.[89] There's a progression of competency levels beginning at the tactical level with green belts. People who are trained in Six Sigma but work on the projects as part of their regular duties are referred to as Green Belts.[90] All other "belts"

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[85] Ronald D. Snee, "Eight Essential Tools," *Quality Progress* 36, no. 12 (Dec 2003): 86-88.
[86] Lucas, "The Essential Six Sigma," 27-31.
[87] Dave Nave, "How to Compare Six Sigma, Lean, and the Theory of Constraints: A Framework for Choosing What's Best for your Organization," *Quality Progress* 35, no. 3 (Mar 2002): 73-78.
[88] Lauren Bielski, "Getting to Total Quality with Six-Stistical Approach," *American Bankers Association Banking Journal* 95, no. 8 (Aug 2003): 54.
[89] Klefsjo, "Six Sigma Seen as a Methodology…," 31-35.
[90] Roger W. Hoerl, Douglas C. Montgomery, Cathy Lawson, et al, "Six Sigma Black Belts: What Do They Need to Know?" *Journal of Quality Technology* 33, no. 4 (Oct 2001): 391-406

would typically hold a dedicated Six Sigma position. Black Belts act as technical and cultural change agents for quality. They are leaders of small teams implementing Six Sigma projects. Black Belts need to be full time resources, freed up from their normal duties to focus on Six Sigma projects. In most cases, a Black Belt is a leader of a team that is working on a problem, and will usually be responsible for several projects at the same time.[91] Master Black Belts teach, mentor, and develop Six Sigma tools and are full-time teachers of the Six Sigma process.[92] The Master Black Belts have more of a managerial role in that they are often responsible for all Six Sigma projects in a particular area or function.[93]

The overall effort within an organization is typically led by a quality leader, which in Six Sigma jargon is referred to as the "Champion." The Champion's role is primarily strategic and involves developing an implementation strategy, setting objectives, allocating resources, monitoring progress, and so forth.[94] Champions back and promote the Six Sigma initiative and work with other senior leaders of the organization to help drive initiatives into daily operations.[95]

SIX SIGMA AND HEALTHCARE

[91] *Ibid*, 391-406.
[92] Lucier, "G.E. Takes Six Sigma…," 41-46.
[93] Hoerl, "Six Sigma Black Belts…," 391-406.
[94] *Ibid*, 391-406.
[95] Lucier, "G.E. Takes Six Sigma…," 41-46.

There is growing interest in the healthcare sector in Canada and around the world to improve the quality, safety, and efficiency of healthcare delivery. Reports of error abound and healthcare costs are soaring. This portion of the paper will examine the health services sector and use it as an example to demonstrate how the application of the Six Sigma methodology can provide significant improvements in the overall healthcare sector as well as the Canadian Forces Health Services system.

DEFINING THE COMPLEXITY OF HEALTHCARE

The 20th century witnessed a spectacular series of medical and surgical innovations that have vastly expanded the clinical toolbox.[96] Like many industries, however, healthcare is composed of an array of complex systems and structures. It offers astonishing advances in the ability to prevent, diagnose, manage, and cure illness and injury. Nevertheless, despite improved training and a seemingly endless influx of new medications and technological innovations, inefficiencies, errors, resource constraints and a host of other issues threaten and often overburden the delivery of safe, effective, and efficient patient care.[97] The overwhelming complexity of healthcare systems and the expanded menu of options available create a propensity for fragmentation and an increasing ability to inflict harm. It is becoming evident that the modern healthcare system lacks the infrastructure and processes necessary to support the system's complexity and allow it to function as a high reliability organization.

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[96] Martin D. Merry, "Healthcare's Need for Revolutionary Change," *Quality Progress* 36, no.9 (Sep 2003): 31-35.
[97] Carolyn Pexton, "Framing the Need to Improve Healthcare Using Six Sigma Quality," *G.E. Medical Systems* (Jan 2004): n.p.

Healthcare has become highly complex, labour-intensive, and high risk; it has grown far too complex for the system that worked decades ago.[98] Many of the clinical processes have merely evolved over time and as they became more complex, design flaws were even more problematic.[99] Healthcare systems consist of a multitude of components and processes with untold variations and inefficiencies. It relies predominantly on the knowledge and skills of caregivers, and trust in human checking as the basic safety mechanism.[100] Systems with this much complexity require sophisticated design elements to prevent the inevitability of human error that is indigenous to highly labour-intensive, complex endeavours such as healthcare.[101]

MEASURING THE SCOPE OF THE PROBLEM

Prior to formal studies on the prevalence of medical error rates, there was little evidence of the magnitude of the problem. Healthcare organizations felt they had quality improvement systems in place to prevent, detect, and react to errors, and individual practitioners were generally confident in their ability to provide quality care. The first indication of the scope of the problem occurred with the release of the Harvard Medical Practice study in 1991.[102,103] This study estimated that hospitalized patients in the United

[98] Bath Lanham and Pamela Maxson-Cooper, "Is Six Sigma the Answer for Nursing to Reduce Medical Errors and Enhance patient Safety?" *Nursing Economics* 21, no. 1 (Jan/Feb 2003): 38-41.
[99] *Ibid*, 38-41.
[100] *Ibid*, 38-41.
[101] *Ibid*, 38-41.
[102] TA Brennan, LL Leape, NM Laird, et al, "Incidence of Adverse Events and Negligence in Hospitalized Patients. Results of the Harvard Medical Practice Study I," *The New England Journal of Medicine* 324, no.6 (Feb 7, 1991): 370-376.

States were injured as a result of negligence on the part of healthcare providers in about one percent of all hospital admissions, a defect rate of 10,000 per million admissions. This one percent error rate was characterized as comfortingly low by some observers when the study was released, but it is 3000 times worse than the Six Sigma goal.[104]

The release of the United States National Academy of Science Institute of Medicine Report, entitled "*To Err Is Human, Building a Safer Health System*," in 1999, brought the prevalence of medical errors and patient safety to the forefront.[105] Consumers were shocked to learn that although healthcare may be remarkable for its technological achievements, it is also potentially dangerous, even lethal, in its execution.[106] In their report, the Institute of Medicine estimated that between 44,000 and 98,000 deaths occur in the United States each year as a result of medical errors. They concluded that good people are working in bad systems.[107]

Three years after the Institute of Medicine report was released, a study published in the highly respected medical journal, the Annals of Internal Medicine, reported that 19% of medications dispensed in hospitals are erroneous on one or more criteria.[108] That

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[103] LL Leape, TA Brennan, NM Laird, et al, "Incidence of Adverse Events and Negligence in Hospitalized Patients. Results of the Harvard Medical Practice Study II," *The New England Journal of Medicine* 324, no.6 (Feb 7, 1991): 377-384.
[104] Mark R. Chassin, "Is Health Care Ready for Six Sigma Quality?" *Milbank Quarterly* 76, no. 4 (1998): n.p.
[105] Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, Editors, "*To Err is Human: Building a Safer Health System,"* Report Prepared by the Committee on Quality of Health Care in America, Institute of Medicine (National Academy Press: Washington, D.C.): News Release issued Nov 29, 1999 and available from http://www4.nationalacademies.org/news.nsf/isbn/0309068371?OpenDocument.
[106] Lanham, "Is Six Sigma the Answer to Nursing…," 38-41.
[107] Ibid, 38-41.
[108] Lazarus, "Six Sigma Relies on…," 1-3.

translates to a Six Sigma level of 2.4.[109] The cost of poorly performing processes has been estimated at approximately 30% of the United States' $1.3 trillion annual healthcare costs.[110] There is growing pressure in the United States and around the world to develop strategies to reduce these costs and improve the safety of healthcare.

In the most comprehensive study of adverse events[111] in Canadian acute care hospitals, Baker and Norton found that the overall incidence of adverse events was 7.5%.[112] Extrapolated to the 2.5 million annual admissions to acute care hospitals in Canada, approximately 185,000 were associated with an adverse event, 70,000 of which they believe were potentially preventable. They also estimated that death occurred in 20.8% of those with an adverse event, 9% of which were judged to have been highly preventable. Extrapolating this figure to the 2.5 million patient admissions, provides an indication that between 9250 and 23,750 deaths could have been prevented.[113] Baker and Norton and other experts conclude that the greatest gains in improving patient safety will come from modifying the work environment of healthcare professionals, and creating better defences for averting errors and mitigating their effects. In their article published in the Canadian Medical Association Journal, Baker and Norton state that, "Efforts to make patient care safer will require leadership to encourage the reporting of adverse events,

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[109] Ibid, 1-3.
[110] Edgeman, "Six Sigma in Metaphor…," 25-30.
[111] Baker and Norton defined adverse events as unintended injuries or complications that are caused by healthcare management, rather than by the patient's underlying disease, and that lead to death, disability at the time of discharge or prolonged hospital stays. Previous studies have show that 37%-51% of adverse events are potentially preventable. Baker and Norton found that 36.9% of the patients studied were judged to have a highly preventable adverse event.
[112] Ross G. Baker, Peter G. Norton, Virginia Flintoft, et al, "The Canadian Adverse Events Study: The Incidence of Adverse Events Among Hospital Patients in Canada," *Canadian Medical Association Journal* 170, no. 11 (May 25, 2004): 1678-1686.
[113] *Ibid*, 1678-1686.

continued monitoring of the incidence of these events, the judicious application of new technologies and improved communication and coordination among caregivers."[114] A case could also be made for the introduction of an innovative quality improvement program, such as Six Sigma.

By assessing healthcare on the Six Sigma scale of quality, there are some frightening observations. A 1997 study showed that only 21 percent of heart attack survivors were prescribed beta-blockers, a class of medication that was previously demonstrated to save lives, which led to a 75% higher death rate in patients who did not receive the drugs.[115] This amounts to a defect rate of 790,000 per million, or less than one sigma. Other studies in the late 1990s demonstrated that 21 percent of all antibiotics prescribed to ambulatory patients are used to treat colds and other viral respiratory infections, conditions for which the antibiotics are useless.[116] This represents a defect rate of 210,000 per million, a Six Sigma level of approximately two. The inappropriate prescribing of antibiotics serves no useful clinical purpose, can lead to adverse reactions, increases the opportunity for the development of drug resistance, and is a waste of money. According to IMS Health, the world's leading provider of health information and consulting services to the pharmaceutical and healthcare industries, there were over 23 million prescriptions for anti-infective medications in Canada in 2004.[117] Assuming that

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[114] *Ibid*, 1678-1686.
[115] S.B. Soumerai, T.J. McLaughlin, D.Spiegelman, et al, "Adverse Outcomes of Underuse of Beta-Blockers in Elderly Survivors of Myocardial Infarction," *Journal of the American Medical Association* 277, no. 2 (Jan 8, 1997): 115-21.
[116] Chassin, "Is Health Care Ready for Six Sigma…," n.p.
[117] IMS Health, "*Growth in Retail Prescriptions Slows in 2004*," available from http://www.imshealthcanada.com/htmen/4_2_1_54.htm

the 21% inappropriate prescribing statistic remains valid in 2004, there were close to 5 million inappropriately prescribed antibiotic prescriptions in Canada alone.

If the performance of high reliability industries suddenly deteriorated to the level of some of the healthcare services cited above, some astounding results would occur. For example, at a defect rate of 20%, such as that identified for antibiotic prescribing, the credit card industry would make daily mistakes on over one million transactions, banks would make over 36 million accounting errors every day, and deaths from airplane crashes would increase one thousand fold.[118] Granted, there can be no direct comparisons made between the various industry sectors, particularly with respect to the outcome of an error; however, the calculations made above certainly provide some entertaining shock value.

A question for healthcare providers could be, "is 99% quality, as was seen in the Harvard Medical Practice Study, good enough for healthcare?" Community pharmacists in Canada dispensed 381,590,000 prescriptions in 2004.[119] At an error rate of 1%, there would have been close to four million wrong prescriptions dispensed - most simply trivial errors with no harm inflicted on the patient, but some would undoubtedly have disastrous results. Similarly, pharmacists dispensed 565,000 prescriptions to Canadian Forces members in 2004 – being correct 99% of the time would have produced over 5,000 prescription errors. A case can also be made for lab tests, radiological exams, surgical procedures, analysis of electrocardiograms, and many other essential aspects of clinical

[118] Chassin, "Is Health Care Ready for Six Sigma…," n.p.

care. Clearly in most facets of healthcare, 99% quality is not good enough – too many people will be harmed. Current quality improvement initiatives have not been effective in systematically improving the quality and safety of the healthcare system. Healthcare can, and must, do better. High reliability organizations in other sectors have created systems and processes that prevent, anticipate and compensate for errors – unfortunately, healthcare has been slow to follow.[120]

As the studies described above have shown, medical errors are not rare events. They are not simply unpredictable or inevitable consequences of the modern complex system of healthcare. Rather they are frighteningly common, often predictable, and frequently preventable.[121] Without a system for adequate quality and safety, patient harm will continue for the foreseeable future.[122]

ANALYZING AND IMPROVING THE SYSTEM

The quality of healthcare delivery is highly dependent on integrating complex systems, as well as coordinating the actions of numerous healthcare professionals and support personnel working in concert on behalf of the patient. Unfortunately, there are a significant number of documented preventable complications in healthcare that arise from flaws in the basic structure of the healthcare system per se. In fact, most errors in healthcare result in part from poorly designed complex systems which cause them to be

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[119] IMS Health, "*Growth in Retail Prescriptions Slows in 2004*," available from http://www.imshealthcanada.com/htmen/4_2_1_54.htm
[120] Chassin, "Is Health Care Ready for Six Sigma," n.p.
[121] *Ibid*, n.p.

error prone.[123] In manufacturing, where Six Sigma originated, it is possible to eliminate much of the human variability in a process through automation, and by creating a precise measurement of the causes of variability.[124] The delivery of patient care however is largely a human process, and the causes of variability are often more subtle and difficult to quantify.[125] Healthcare systems also depend upon idealized standards of performance that require healthcare professionals to perform tasks to a level of perfection that in many cases cannot be achieved by humans.[126]

Despite the introduction of various quality improvement programs in healthcare organizations, medical errors still occur at an unacceptable rate.[127] Analysts postulate that the reason many current medical error reduction initiatives fall short is the fact that they do not produce the level of detail required to understand process variation. A program like Six Sigma offers hope for significant improvement in the delivery of healthcare, particularly in the reduction of errors.[128]

Healthcare quality assurance activities have also been largely reactive – they take a bad outcome and then search for an individual to blame.[129] Systematic analysis will often demonstrate that faulty systems are responsible for errors more often than

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[122] Merry, "Healthcare's Need for Revolutionary…," 31-35.
[123] Cathy Buck, "Application of Six Sigma to Reduce Medical Errors," *Quality Progress – ASQ's Annual Quality Congress Proceedings* (2001): 739-742.
[124] Sehwail, "Six Sigma in healthcare," 1-5.
[125] Ibid, 1-5.
[126] Chassin, "Is Health Care Ready for Six Sigma…," n.p.
[127] Lee Revere and Ken Black, "Integrating Six Sigma with Total Quality Management: A Case Example for Measuring Medication Errors*," Journal of Healthcare Management* 48, no.6 (Nov/Dec 2003): 377-391.
[128] *Ibid*, 377-391.
[129] Chassin, "Is Health Care Ready for Six Sigma…," n.p.

individuals.[130] The other problem with only analyzing bad outcomes is that it does not address near misses, errors discovered before impacting on the health of a patient. For example, most medication errors that do not result in patient harm or death go unreported. Few healthcare organizations have developed a culture similar to high-reliability industries, where the reporting and analysis of near misses is extensively utilized. The airline and air traffic control sectors have achieved high levels of safety, in part because the reporting and analysis of near misses is ingrained into the culture of all employees.

Healthcare providers are now looking to other industries to seek a results-focused, structured methodology, such as Six Sigma, to identify and manage the root causes of quality and efficiency problems.[131] There is a strong rationale for using Six Sigma to improve the safety, effectiveness, and efficiency of healthcare. Defects in the delivery of patient care are perhaps more critical than in any other setting.[132] The management philosophy surrounding Six Sigma, that to seek a near-zero error rate is highly suitable in the healthcare sector because many healthcare interventions demand a near-zero tolerance for mistakes.[133] Current quality improvement systems are clearly not as effective as they need to be for such critical processes.

The current healthcare system is also built around the needs of healthcare professionals, where the tasks of diagnosing and treating seemingly take precedence over the creation of a patient-centered system of care that attends to the patients' broader

[130] *Ibid*, n.p.
[131] Walter H. Ettinger, "Six Sigma – Adapting G.E.'s Lessons to Health Care," *Trustee* (Sep 2001): 10-15.
[132] *Ibid*, 10-15.
[133] Revere, "Integrating Six Sigma with Total Quality Management," 377-391.

human needs.[134] A Six Sigma approach would foster the development of a true patient-centered system focusing on clinical excellence while seeking the maximum ease of use and comfort for patients.[135] A secondary goal for the customer identified as the payer of the services is efficiency - minimizing the cost of services. In healthcare, Six Sigma is specifically designed to help organizations reduce the defects that diminish the quality of care as well as drive up costs.[136]

Where it has been implemented, Six Sigma is being accepted by both clinicians and healthcare executives because it provides a detailed, measurable, and sustainable methodology. Physicians in particular are often receptive to the idea of Six Sigma because it is an evidence-based, scientific approach to problem solving and improvement.[137] Healthcare organizations can adapt Six Sigma to virtually any process, from a medical procedure to an administrative function. It uses statistical analysis to find the most defective part of the process, and rigorous control procedures to sustain improvement. Six Sigma calls on the voice of the customer - be that a patient, family member or a member of the clinical team – to define acceptable performance. In that respect, Six Sigma correlates well with the traditional pillars of healthcare, including quality, safety, accessibility, timeliness, effectiveness, and efficiency.[138]

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[134] Merry, "Healthcare's Need for Revolutionary Change," 31-35.
[135] Ibid, 31-35.
[136] Ettinger, "Six Sigma – Adapting G.E.'s…," 10-15.
[137] Pexton, "Framing the Need…," n.p.
[138] Lazarus, "Six Sigma Relies…," 1-3.

Six Sigma has the potential to achieve exponential quality improvement through the reduction of variation in healthcare processes.[139] It can improve the quality of healthcare throughout the entire system – organization by organization, department by department, process by process.[140] By adopting its customer-focused, statistically based, and structured methodology, Six Sigma can take health care to the next level of quality and patient satisfaction.[141]

CONTROLLING THE PROCESS AND MAINTAINING MOMENTUM

As with any new initiative, when implementing Six Sigma, it's important to have strong buy-in and involvement of key stakeholders across the organization. In the healthcare setting, the most influential stakeholders are physicians, who are often sceptical of process improvement initiatives.[142] In a hospital or clinic setting, the management team often feels that the clinicians veto or resist initiatives without becoming involved. They feel that physicians in particular can circumvent institutional procedures and rarely get involved unless an issue directly affects their practices.[143] Six Sigma can help bridge the gap between clinicians and healthcare executives. Since it is highly quantitative, physicians appreciative the nuances of sampling, hypothesis testing, and statistical analysis, and it allows them to efficiently monitor the progress of a particular Six Sigma project.[144] Executives like the fact that Six Sigma achieves lasting

[139] Revere, "Integrating Six Sigma with Total Quality Management," 377-391.
[140] Ettinger, "Six Sigma – Adapting G.E.'s…," 10-15.
[141] Revere, "Integrating Six Sigma with Total Quality Management," 377-391.
[142] Ettinger, "The Art and Science…" 34-38.
[143] *Ibid*, 34-38.
[144] *Ibid*, 34-38.

results. It demonstrates that without continuous monitoring and fundamental changes in systems and processes, problems will recur and improvements will not be sustained.[145]

There are various methods that have been proposed to gain physician support for Six Sigma. These methods may apply equally to all healthcare providers but they are particularly germane from a physician standpoint. The following approach was extracted from an article written by Dr. Walter Ettinger and Dr. Mark Van Kooy, two physicians with significant experience in Six Sigma projects.[146] First, focus on clinical processes that are the sole responsibility of the healthcare system in question and that are important to physicians. Ask them about day-to-day issues that impede their efficiency. Fixing these mundane problems may build credibility with physicians. Throughout the process, it is important to be clear about the level of physician involvement required for each Six Sigma project. Careful planning can lead to efficient use of physician time and increase their support – a sort of "just-in-time" physician involvement. A physician advisory group that meets only when truly necessary can provide important guidance to the Six Sigma project teams. During projects, seek early wins for physicians and ensure that data provided is well supported and applicable to their area of practice. Physicians are adept at identifying flaws in data collection and analysis and have been trained throughout their careers to question data presented to them. Only data and conclusions that withstand intense examination will be accepted within the physician community.[147]

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[145] *Ibid*, 34-38.
[146] *Ibid*, 34-38.
[147] *Ibid*, 34-38.

To properly control Six Sigma implementation, gain acceptance throughout the organization, and maintain the momentum of the initiative, it is important to have a clear understanding of the customer. The primary "customer" in healthcare is of course the patient; nevertheless, there are other customers who must also be taken into consideration. Other customers may be family members, the government, taxpayers, an insurance company, or an individual paying for the services directly. As well, the customer may be other members of the healthcare profession involved in the care of a particular patient. One of the biggest challenges is finding the right balance between achieving the best clinical outcome for the patient while reducing the costs for the payer.[148] The advantage with the Six Sigma methodology is that its structured approach allows for a clear identification of who the customers are for all processes.

Health care organizations are facing ever-growing pressures to trim costs while still enhancing their services. The risk of delivering high quality care within budgetary constraints is becoming more and more difficult with the increasing use of expensive technologies, the complexity of procedures, the redundancy of administrative processes, and the high rate of errors. As well, patients are becoming more knowledgeable because of the proliferation of medical information on the internet. As a result, healthcare organizations are turning to Six Sigma principles to improve patient care while realizing significant financial savings. There is a vast potential in health care to improve quality and reduce costs using Six Sigma quality tools.[149]

[148] Anonymous, "Six Sigma for Success in Health Care," 67-69.
[149] *Ibid*, 67-69.

SIX SIGMA AND THE CANADIAN FORCES HEALTH SERVICES

This portion of the paper is designed to present a case for employing the Six Sigma methodology in one small area within the Canadian Forces – the health services system.[150] By examining the problems related to quality, safety, and efficiency in the civilian healthcare system, comparisons can be made to the military health services system. Additionally, various audits, reports, and grievances over the past decade have highlighted quality and efficiency problems with the Canadian Forces Health Services system thereby reflecting the similarities to the civilian system. Project Rx2000 was established in 2000 with the aim of creating a patient-focused, accessible and universal healthcare system that is delivered by a multi-disciplinary, fully deployable healthcare team. – a vision that greatly reflects the Six Sigma philosophy. Under the guise of Rx2000, a number of initiatives have been developed and implemented in an effort to improve healthcare services for members of the Canadian Forces. These have been highly successful, but more can be done to enhance quality, safety, and efficiency. There are opportunities for Six Sigma projects to take the military healthcare system to the next level of excellence. One such trial project, conducted by a member of the Canadian Forces Health Services in conjunction with another researcher, demonstrated how Six Sigma can improve customer satisfaction and save money.[151] The project assessed waiting times, cancelled appointments, and no-shows for specialist physician

[150] A similar case study could have been made for any number of functional areas within the Canadian Forces, such as human resource management, finance, logistics, research and development, and so on. These areas could serve as the focus for future research on Six Sigma applications.
[151] Louise Sylvestre and John Hogan, "Six Sigma, a Methodology to Improve the Efficiency in the Specialty Clinic and the Delivery of Health Care Services Within the Canadian Forces Health Services in Ottawa," (master's thesis, University of Ottawa, 2004): 5-7.

appointments at the Canadian Forces Support Unit Ottawa Health Services Centre. Previous attempts aimed at identifying and correcting scheduling problems using a Continuous Quality Improvement approach were ineffective. Through application of the DMAIC model and detailed statistical analysis, they determined that there were a significant number of patients not showing up for scheduled appointments. Overall, the appointment scheduling process was functioning at a 68% efficiency level and was causing significant dissatisfaction among patients who felt that the waiting times to get an appointment were excessive. Improvements to the system are now underway for the specialist clinic and other areas of the facility.

In summary, the Canadian Forces Health Services should look to Six Sigma to improve clinical outcomes, the quality and safety of healthcare delivery, patient satisfaction, and, to reduce the costs of health care services. It is apparent that the application of the Six Sigma methodology is extremely powerful in identifying, quantifying and controlling complex healthcare systems.[152] Profound organizational commitment and extensive staff training will be necessary to effect and sustain lasting improvements.[153]

SIX SIGMA AND FRATRICIDE

In the previous section, the military healthcare system was described as an area where the application of Six Sigma could produce tremendous gains in safety,

[152] Buck, "Application of Six Sigma…," 739-742.
[153] *Ibid*, 739-742.

effectiveness, and efficiency. There are many other transaction-based functional areas within the Canadian Forces where Six Sigma may also provide significant improvements in quality. One area that has been difficult to assess from a quality improvement stand-point is the military operational realm, more specifically, when problems arise in the conduct of military operations such as war-fighting. This portion of the paper will analyze one of the most devastating consequences of battlefield error – fratricide – to determine if the utilization of Six Sigma could help reduce the risk of this tragic aspect of combat operations.

DEFINING THE PROBLEM

"Cease fire! Friendlies!" cried U.S. Army Specialist Pat Tillman as he lay dying on a stony ridge in south-eastern Afghanistan.[154] The former professional football player with the Arizona Cardinals had walked away from a $3.6 million contract to become a soldier after the 9/11 attacks in the United States. Tillman died on the early evening of April 22nd, 2004 as a result of friendly fire from members of his own unit. They did not recognize him, nor did they hear his cries to stop shooting.

Friendly fire is somewhat of a misnomer. Not only is it a contradictory term, but it also has an ironic or cynical connotation.[155] It certainly does not provide solace for the family members of persons killed in battle, when they find out that their loved one was a

[154] Steve Coll, "Barrage of Bullets Drowned Out Cries of Comrades," *Washington Post*, 5 December 2004, A01.
[155] Richard Townshend Bickers, *Friendly Fire: Accidents in Battle from Ancient Greece to the Gulf War* (London: Leo Cooper, 1994), 1.

victim of fratricide.[156] Unfortunately, as Richard Bickers points out in his historical survey of some of the most dramatic incidents of friendly fire, "it is an occurrence as old as war itself."[157]

Fratricide is indeed a concept that dates back to the time when men first took up arms against their enemies. Thucydides reported it in ancient Greece in 413 B.C.[158] In the Middle Ages, English archers were feared for the great range of their arrows, many of which ended up in the backs of their own cavalrymen.[159] During the great war of 1914-1918, and World War II an untold number of sailors, soldiers, and airmen lost their lives when they became unintentional targets of their own or allied forces. Bickers describes World War I as being "prolific in self-destructive incidents."[160] The single most famous case of fratricide in World War II occurred as troops prepared for the Normandy breakout near St. Lo. Carpet bombing of German positions by Allied bombers went dreadfully wrong as short bombings, bombs that land short of the target or bomb line, landed where American troops were positioned resulting in 111 dead and 490 wounded.[161]

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[156] The nomenclature for friendly fire is somewhat confusing. The term "friendly fire" is commonly used in the lay press because most people understand what it means, even if it is a misnomer. "Fratricide" refers to the killing of one's brother and by extension one's brother in arms. Others use the term "amicicide" which refers to the killing of friends. Throughout this paper, the terms fratricide and friendly fire will be used interchangeably.
[157] Bickers, *Friendly Fire*…, 2
[158] *Ibid*, 3.
[159] *Ibid*, 3.
[160] *Ibid*, 42.
[161] United States Congress, Office of Technology Assessment, *Who Goes There: Friend or Foe?* OTA-ISC-537 (Washington, DC: U.S. Government Printing Office, June 1993), 12-14.

Conflicts of the 1950s and 1960s were rampant with incidents of fratricide. In Korea, the Americans, British, Canadians, and Australians were all afflicted by it.[162] During the Vietnam War, the Americans seemingly accepted an overwhelming number of incidents of fratricide as an unfortunate part of war.[163] One of the worst cases of fratricide in the Vietnam War involved an artillery unit that aimed its guns correctly but used the wrong powder charge. The rounds went too far and landed on another American artillery position. The second position responded with deadly accurate counter-battery fire. This duel went on for over 20 minutes and resulted in 90 casualties, all from friendly fire.[164]

Canadian troops have not been immune to fratricide. On August 7th, 1944, as the British Army thrust towards Falaise, twenty-four American B-17 Bombers dropped 90,000 pounds of fragmentation bombs on the 3rd Canadian Infantry Division and the Polish Armoured Division, killing 86 and wounding 376.[165] And of course, there was the incident at Tarnak Farms in Afghanistan that took the lives of four Canadian soldiers.

Just as deadly are incidents involving civilians, through misidentification or collateral damage. In 1988 for example, an echo on the radar of the United States Ship Vincennes was thought to be from a hostile aircraft. The aircraft was shot down but later discovered to be an Iranian Airlines Airbus carrying 290 passengers. Everyone on board

[162] Bickers, *Friendly Fire*…, 147.
[163] Bickers, *Friendly Fire*…, 148.
[164] United States Congress, Office of Technology Assessment, *Who Goes There…,* 11.
[165] Bickers, *Friendly Fire*…, 124-25.

perished.[166] Although this accident, and other incidents of civilians being harmed, is not a true case of fratricide, it is equally tragic, and similarly reflects a flawed system.

Fratricide escalated to extreme heights during the Persian Gulf War when twenty-four percent of all United States combat casualties were caused by friendly fire. There were 615 confirmed American battle casualties during Operation Desert Storm, 148 of which were fatal. Of the 148 fatalities, 35 (24 percent) were caused by friendly fire. Of the 467 nonfatal battle casualties, 72 (15 percent) were caused by friendly fire.[167] Friendly fire was also responsible for 77% of all United States Army combat vehicles destroyed during the war, and there were nine British soldiers killed and 16 injured at the hands of United States Air Force pilots.[168] General Norman Schwartzkopf, Commander of the American Forces during the Persian Gulf War, was quoted as saying,

> The very chaotic nature of the battlefield, where quick decisions make the difference between life and death, has resulted in numerous incidents of troops being killed by their own side in every war that has ever been fought. This does not make it acceptable. Not even one such avoidable death should ever be considered acceptable.[169]

Unfortunately, the story does not end with the Persian Gulf War. On April 14th, 1994, two American UH-60 Black Hawk helicopters were mistakenly identified as hostile

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[166] *Ibid*, 148.
[167] United States Congress, Office of Technology Assessment, *Who Goes There…,* 26.
[168] Bickers, *Friendly Fire*…, 150.
[169] Bickers, *Friendly Fire*…, 155-56.

and fired upon by two United States Air Force F-15C fighter aircraft over northern Iraq.[170] Both helicopters were instantly destroyed resulting in the death of all 26 people on board. In a joint letter of condolence to the families of those who lost their lives in this accident, United States Secretary of Defense William Perry, and Chairman of the United States Joint Chiefs of Staff General Shalikashvili, expressed their commitment to account for these deaths:

> We believe that actions must speak louder than words. This accident should not have happened, but these brave individuals will not have died in vain if we learn from and correct our mistakes. We are determined to do everything in our power to insure that this type of accident is not repeated.[171]

Well, they do not seem to have learned their lessons very well. Despite an extensive investigation into the Black hawk incident of 1994 by an Aircraft Investigation Board, and a 22-volume report with countless recommendations, four Canadian soldiers were killed eight years later under very similar circumstances. It is apparent that a different approach to preventing fratricide is needed.

MEASURING THE SCOPE OF THE PROBLEM

[170] Scott A. Snook, *Friendly Fire: The Accidental Shootdown of U.S. Black Hawks Over Northern Iraq* (Princeton, New Jersey: Princeton University Press, 2000), 4-7.
[171] Snook, *Friendly Fire…,* 7.

The proportion of deaths due to fratricide in the 1990 Gulf War was much higher than the nominal two percent rates frequently cited in the military literature.[172] In June 1993, the United States Office of Technology Assessment released a report that analysed the historical prevalence of fratricide and assessed the technology and techniques available to reduce the incidence. They concluded that many casualties due to fratricide are never realized to be such, and many that are recognized as fratricide are probably never recorded as such. They also noted that, in other instances, the recording of fratricide is suspect because fratricide is a mistake and a full airing can be embarrassing or traumatic and can end careers. Lieutenant-Colonel Charles Schrader's paper, *Amicicide: The Problem of Friendly Fire in Modern War*, contains the largest collection of historical anecdotes of fratricide of any single source and is widely cited in articles related to fratricide.[173]

Although an accurate estimate of the overall frequency of fratricide is impossible to determine, the two percent rule of thumb presented by Schrader and others is almost certainly too low.[174] Broad-based data on fratricide rates are not available; but a recent review of long-extant casualty surveys from World War II and the Vietnam War shows that fratricide estimates of two percent are unrealistic and 15 to 20 percent may be the norm, not the exception.[175] In every case in which good data are available, the actual rate of fratricide turns out to be much higher than two percent. As a result, reducing casualties

[172] United States Congress, Office of Technology Assessment, *Who Goes There…,* 1.
[173] *Ibid*, 8.
[174] United States Congress, Office of Technology Assessment, *Who Goes There…,* 29.
[175] *Ibid*, 1.

from friendly fire requires a systematic analysis to identify the root causes and to look for ways to improve the safety of military operations and prevent this tragic loss of life.

It should be noted that although the effects of fratricide are devastating to the families and friends of those killed, it can also severely impact combat effectiveness and unit cohesion. Fear of fratricide can so inhibit a commander's actions that combat efficiency is significantly reduced. The United States Centre for Army Lessons Learned reports that fratricide increases the risk of mission failure.[176] They list several effects of fratricide that can reduce combat effectiveness. For example fratricide can result in psychological effects that cause soldiers to become too cautious or that causes them to lose confidence in their leaders. In the end, fratricide causes a reduction in military effectiveness.[177]

ANALYSING AND IMPROVING THE SYSTEM

Fratricide almost always results from a complex and confused chain of mistakes.[178] Military systems and the humans that control them have so many components and so many potential behaviours that huge amounts of ingenuity are required to understand how they work and to predict what they will do in different situations.[179] As well, the evolution of a system or process is often path dependent whereby a decision, delay, or mistake at a critical moment can direct the system down a

[176] United States Army Center for Army Lessons Learned, *Fratricide Risk Assessment for Company Leadership* (US Army Combined Arms Command, Fort Leavenworth, Kansas, Mar, 2002), 4.
[177] United States Congress, Office of Technology Assessment, *Who Goes There…,* 19.
[178] *Ibid*, 9.

path that diverges widely from the one it should have followed, and once the system is well down this path, reverting to the original path is almost impossible.[180]

Investigation of particular cases usually reveals that the fratricide was in fact the last link in a chain of mistakes - the final decision to attack a target is the last step in a multi-step process. Most fratricide cases result from errors that could have been avoided if proper information had been available at any one of these intermediate steps.[181] Faulty navigation, poor communication, ineffective command and control, lack of fire discipline, malfunctioning equipment, and misidentification have been cited as causes of fratricide.[182] The United States Center for Army Lessons Learned produced a handbook on fratricide risk assessment in 1992 which provides a more comprehensive review of fratricide contributing factors and the probable causes of fratricide.[183] With multiple links in a chain of causes, there are multiple solutions to the problem of fratricide by strengthening any of the links.[184] Six Sigma, with its rigorous methodological processes, may provide a logical approach to better understanding the variation that can occur at any of the key steps in a battlefield scenario. This may assist in the design of more effective technology, processes, and training and a subsequent reduction in the risk of friendly fire.

In their report on fratricide, the Office of Technology Assessment also concluded that the types of fratricide change much less quickly than military technology. They note

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[179] Homer-Dixon, *The Ingenuity Gap*, 116.
[180] *Ibid*, 154.
[181] United States Congress, Office of Technology Assessment, *Who Goes There…,* 3.
[182] *Ibid*, 3.
[183] United States Army Center for Army Lessons Learned, *Fratricide Risk Assessment for Company Leadership* (US Army Combined Arms Command, Fort Leavenworth, Kansas, Mar, 2002), 4.
[184] United States Congress, Office of Technology Assessment, *Who Goes There…,* 3.

that very few fratricide incidents result exclusively from mechanical malfunction. In almost all cases, fratricide results from deliberate but mistaken human decisions and actions that cause casualties among friendly forces.[185] This suggests that improving technology is only part of the solution; reducing fratricide will always depend on well-designed systems and processes as well as enhancing the training and skills of soldiers, sailors, and air personnel.[186] For example, they hypothesize that some cases of friendly fire in the Persian Gulf War could have been avoided by different pre-war training.[187]

Reducing fratricide will certainly require new technology and equipment, as some accidents due to human error could be avoided by different equipment design.[188] Hence, a "Design for Six Sigma" program could prove beneficial, both within the military and for defence contractors. In fact, a number of contractors have already instituted Six Sigma programs. However, failure of command and control and straightforward misidentification are far more common causes of fratricide than technological failures.[189] High-reliability organizations also maintain failure free performance by investing a large portion of their resources in preventative planning, careful analysis of their mistakes, and the development of well-defined processes and highly competent employees, especially when the pace and complexity of decision-making are high.[190] Analyzing and improving processes will therefore have a much greater impact on fratricide reduction – another opportunity for the application of Six Sigma techniques.

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[185] *Ibid*, 32.
[186] *Ibid,* 28.
[187] *Ibid*, 4.
[188] *Ibid*, 5.
[189] *Ibid*, 17.
[190] Homer-Dixon, *The Ingenuity Gap*, 185.

In the *Logic of Failure*, Dörner argues that mistakes are essential to cognition; however, when dealing with complex systems, it is difficult to pinpoint the precise cause of the error.[191] In reality, crises such as fratricide rarely occur in exactly the same fashion. Opportunities for individuals or organizations to bring experience gained from one crisis to another of the same kind are therefore quite rare. Simulations can place people in the same kind of crisis over and over to hone their sensibilities to the specific features of various situations.[192] Simulators are an increasingly important part of training in high reliability industries. Unfortunately, simulator systems have not generated sufficient opportunities for fratricide prevention.[193] A "Design for Six Sigma" process could help produce the needed scenarios for dedicated simulator training related to fratricide.

CONTROLLING THE SYSTEM

Reducing fratricide is desirable and feasible, but eliminating it completely is highly unlikely.[194] Friendly fire still happens and likely always will.[195] Although programs to reduce fratricide are needed, setting a goal of eliminating fratricide is unrealistic and probably even counterproductive to combat effectiveness.[196] Nevertheless, the development of a reliable anti-fratricide system could save lives and

[191] Dorner, *The Logic of Failure*…, 199.
[192] *Ibid*, 199.
[193] United States Congress, Office of Technology Assessment, *Who Goes There…,* 4.
[194] *Ibid*, 2.
[195] Bickers, *Friendly Fire*…, 157.
[196] United States Congress, Office of Technology Assessment, *Who Goes There…,* 2.

open up new tactical options. Better identification could allow more rapid attacks on enemy strong points, more aggressive defense, closer and more agile air-to-ground or artillery support, and so on.[197]

The shift towards asymmetric warfare and the "three block war" concept will also require the development of innovative concepts, doctrine, and systems, not simply more advanced weapons. From a military perspective, Six Sigma may provide the innovative solutions that can change the very nature of the way that a conflict is prosecuted.[198]

IMPLEMENTING SIX SIGMA

Once a case has been made to utilize Six Sigma as a quality improvement methodology, whether that is broadly across the entire Canadian Forces, or in selected functional areas, there needs to be a logical approach to implementation. As Homer-Dixon states, "The supply of ingenuity dedicated to solving problems involves both the generation of good ideas and their implementation."[199] It is not enough for an organization to simply think up an idea to solve a problem such as fratricide or medical errors - the idea must also be deployed before it can generate results. This section of the paper is not meant to provide comprehensive policies and guidelines on how to implement a Six Sigma program – it is simply meant to present some critical factors that

[197] *Ibid*, 30.
[198] Colonel John B. Alexander, *Winning the War: Advanced Weapons, Strategies, and Concepts for the Post 9/11 World* (New York: Thomas Dunne Books, 2003), 225.
[199] Homer-Dixon, *The Ingenuity Gap*, 23.

can contribute to success, and provide a general approach for the implementation of Six Sigma in the Canadian Forces milieu.

PRINCIPLES FOR SUCCESSFUL IMPLEMENTATION

The successful implementation of Six Sigma relies on the adherence to a number of key principles regarding both the Six Sigma methodology and change management strategies. John Kotter's eight-stage process for creating major change from his book *Leading Change* provides a structured framework for implementing a program such as Six Sigma.[200]

Kotter's first two stages are to establish a sense of urgency, and create a guiding coalition.[201] As with any new initiative, successful implementation of Six Sigma requires strong support from the leadership of the organization – a coalition with enough power to lead the change initiative. Without this leadership commitment, employees will question the importance and rationale of the initiative. Those who have successfully implemented Six Sigma agree that the most important factor is continued top management support and enthusiasm.[202] There also needs to be an effective organizational structure in place with employees who have been trained to lead and execute Six Sigma projects.[203] The sense of urgency is developed via the first two stages of the DMAIC cycle – defining and measuring the problem. For example, an analysis of fratricide and other injuries and

[200] John P. Kotter, *Leading Change* (Boston, Massachusetts: Harvard Business School Press, 1996), 20-21.
[201] *Ibid*, 20-21.
[202] Coronado, "Critical Success Factors…," 92-99.
[203] Antony, "Key Ingredients for the Effective…," 20-27.

death resulting from military training or operations may bring to light the seriousness of the problem. Similarly, a measurement of the rate of medical errors backed up by hard data can certainly create a sense of urgency once the scope of the problem has been fully elucidated.

To successfully implement Six Sigma, it is essential to link the philosophy to the organizations' strategy and most importantly to its customers. This is why it is critical for the customer to be clearly identified before proceeding with a Six Sigma project. In other words, Six Sigma should not be treated as a stand-alone activity. Kotter's third stage in creating change is to develop a vision and a strategy.[204] It needs to be clear how every Six Sigma project links to the customer, to core processes, and to the overall vision and mission of the organization.[205]

A successful implementation also requires a cultural adjustment within the organization. From a Canadian Forces perspective, embracing quality improvement as a concept is likely the most important cultural change required. Military personnel tend to be task and goal-oriented - focusing on quality improvement, particularly on a system that originated in the business sector will not be an easy sell. Additionally, rather than simply focusing on finishing a task, military personnel need to understand that everything they do involves a process and they will need to be motivated to accept responsibility for the quality of their work.[206] The only way to do this is through structured training

[204] Kotter, *Leading Change,* 20-21.
[205] Antony, "Key Ingredients for the Effective…," 20-27.
[206] *Ibid*, 20-27.

programs and clear communication of the change vision – Kotter's fourth stage.[207] Six Sigma is more than just training black belts who tackle quality and efficiency issues in isolation. Instead, successful Six Sigma programs must become cultural revolutions that involve every member of an organization.[208] As Kotter describes it in his fifth stage, employees must be empowered to remove obstacles and take broad-based action.[209]

Once a problem has been defined and measured, the customer identified, and the problems analyzed, it is time to take action to improve defective processes. As Six Sigma is a project driven methodology, it is essential to prioritize projects and focus on those that provide maximum benefit to the organization, and it is beneficial for project leaders to have some basic project management skills.[210] In the early stages, it is best to look for highly visible projects that will generate short-term wins. This sixth stage in Kotter's process is crucial to the acceptance of Six Sigma by both the leadership team and the employees, as they will have invested time and money to implement the Six Sigma project. It is therefore essential to have clear goals and quantitative measures of success – to the customer and the organization.

Kotter's last two stages involve consolidation of gains and anchoring the new approach into the culture of the organization.[211] This fits well with the control phase of the DMAIC cycle where projects are closely monitored, other projects are initiated, and the culture of Six Sigma spreads throughout the organization. People begin to look for

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[207] Kotter, *Leading Change,* 20-21.
[208] John M. Gross, "A Road Map to Six Sigma Quality," *Quality Progress* 34, no. 11 (Nov 2001): 24-29.
[209] Kotter, *Leading Change,* 20-21.
[210] Coronado, "Critical Success Factors…," 92-99.

better ways of doing things in everything that they do. By following these guiding principles and incorporating them within a change management process such as the one developed by Kotter, the chances for a successful Six Sigma implementation will be enhanced immensely.

APPROACHES TO IMPLEMENTATION

There are a number of different approaches to implementing successful Six Sigma projects. Proper project selection is critical, but it is also important to select the right people to work on the project and to ensure that they have the necessary training and resources to complete the project.[212] To implement Six Sigma in the Canadian Forces, there are three basic approaches that can be followed: a mandated, strategic-level, department-wide, top-down approach led by the senior leadership; a project-by-project, bottom-up, tactical approach; and, a middle of the road, operational-level, hybrid between a top-down and bottom-up strategy.

Top Down

When Jack Welch introduced Six Sigma at General Electric, he implemented it with a vengeance. He appointed many of his best people as Six Sigma leaders, pulling them off their existing jobs and giving them two-year project assignments to qualify as

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[211] Kotter, *Leading Change,* 20-21.
[212] Ronald D. Snee, "Dealing With the Achilles' Heel of Six Sigma Initiatives," *Quality Progress* 34, no. 3 (Mar 2001): 66-72

"Black Belts."[213] He also trained thousands of employees as "Green Belts", and provided training to his senior management team. Welch also changed his company's incentive compensation plan so that 40% of bonus pay was based on Six Sigma results. Six Sigma qualifications and a commitment to the program were required before anyone was appointed to a management position at General Electric.[214]

This CEO driven approach was right for Welch and General Electric and is the methodology recommended by many Six Sigma proponents. However, in order to successfully implement an innovative program like Six Sigma enterprise-wide, there needs to be strong leadership commitment, an urgent need to implement the program, and significant up-front investment. In the current Canadian Forces environment, where enormous reforms are currently underway, it would be difficult to dedicate the staff or funding to undertake an all out push for Six Sigma. It would also generate significant resistance from those who have seen other programs like Total Quality Management, Balanced Scorecards and Business Planning inflicted upon them from "headquarters." The sceptics would also see Six Sigma as another fad from the business world that will not work for a unique organization like the military – "we're different!" Another problem with the top down approach in the Canadian Forces is that culturally, it is very difficult to transmit new policies and procedures through the system. The Headquarters bureaucracy often ends up blocking, changing, or filtering new programs. For the Canadian Forces, a top-down approach would most likely fail.

[213] Jack Welch, "Jack: Straight…," 325-40.
[214] *Ibid*, 325-40.

Bottom Up

A more rational approach would be to identify small projects at the tactical level and look for improvements via Six Sigma. This would require lower level leaders who have the vision, initiative, energy, and commitment to try something new. The advantage with this approach is that word of its success would spread through the "best practice" net and others would recognize the opportunity to tackle problems within their respective areas of responsibility. If it generated enough success at the tactical level, it may reach what Gladwell describes as "the tipping point"[215] when it spreads rapidly across the department and through this osmosis becomes the Canadian Forces' approach to quality improvement. Of course, with this bottom-up approach, there may be a lack of standardization in how the process is applied, or duplication of effort, which could lead to selective project failures, and a negative impression regarding Six Sigma.

Middle of the Road

There are many potential hybrid, or middle of the road approaches that could be investigated. Typically, a middle of the road approach would require buy-in, general awareness, and support of the senior leadership, but ownership would be at lower levels within the Department, perhaps at the Level 2 Business Line. The Level 2 leaders would have their own set of Six Sigma projects and staff and determine their extent of application, under the overall guidance of a Departmental Champion. There would of

[215] Malcolm Gladwell, *The Tipping Point* (New York: Little, Brown, and Company, 2000), 7.

course still need to be a distinct bottom-up stimulus to generate the Six Sigma projects and opportunities.

According to a framework proposed by Snee, taking a middle ground approach to Six Sigma implementation encompasses three steps of increasing magnitude.[216] First, select two or three areas in which to initiate Six Sigma. In the CF, this could be the healthcare system, the logistics system, defence research and development, or any number of institutions that have well-defined customers, and complex processes that could serve as foci for a Six Sigma project. Remembering that according to Dr. Joseph Juran, the father of modern quality improvement, all improvement occurs project by project.[217] Next, Snee recommends spreading it to adjacent areas as experience with Six Sigma grows in the initial areas. As the root causes of problems are uncovered, additional opportunities for improvement projects will likely be identified and prioritised.[218] Finally, integrate improvement efforts into an overall organizational improvement system.

As Six Sigma utilization spreads throughout the organization, coordination and control will be necessary to ensure that improved performance does not diminish, and that Six Sigma eventually becomes the way that the organization functions.[219] People will always be looking for better ways of doing things. They will think of everything that they do as a process, they will understand and work to reduce variation, they will use data to

[216] Snee, "Weave Six Sigma…," 69-72.
[217] De Feo, "Creating Strategic Change More Efficiently…," 60-80.
[218] Snee, "Weave Six Sigma…," 69-72.
[219] *Ibid*, 69-72.

guide their decisions, and they will maintain a focus on improvement and control of processes.[220]

To facilitate leadership commitment to this approach, the process should commence by educating the senior leadership team on Six Sigma.[221] The best way to accomplish this for the Canadian Forces would be to contract a reputable Six Sigma training firm to develop a training program geared to the specific needs of the military - in other words, to present it in a less business-oriented fashion. A one-day session during one of the retreats attended by all Generals and selected senior civilian staff would suffice. The goal is not to make them experts, but to provide them with an awareness of the concepts, statistical terms, and methodology of Six Sigma. It would also prove useful to engage a consultant to assist the leadership in scoping out the project, developing project areas, determining resource requirements and helping them determine if they are interested and ready to pursue a Six Sigma program in their respective areas.[222]

Once it has been decided to proceed, a Six Sigma Champion should be appointed. Since the focus of Six Sigma is quality and efficiency, and the Treasury Board of Canada Secretariat may show an interest in the program, the most appropriate Champion for DND is the Deputy Minister. The Champion will need to assemble an implementation team, develop the implementation road map, and act as the change agent who is ready to move the Department toward reducing variation, improving quality, and creating

[220] *Ibid*, 69-72.
[221] Gross, "A Road Map to Six Sigma Quality," 24-29.
[222] *Ibid*, 24-29.

efficiency.[223] Initially, one full-time person should be trained to the Master Black Belt level to serve as a mentor for those within the Department who are leading Six Sigma projects. This individual would work for the Deputy Minister.

If aiming for this middle ground approach, the challenge will be to ensure that Six Sigma is practised on a scale extensive enough to make a real difference to the organization, yet intensive enough to keep the effort focused and manageable within operational, budgetary, personnel, and time constraints.[224]

ADAPTING SIX SIGMA TO THE CANADIAN FORCES ENVIRONMENT

The ultimate goal of a quality improvement initiative is to improve the effectiveness and efficiency of the organization. Six Sigma does this by focusing on the customer's needs, and applying a rigorous methodological and statistical approach. To achieve success in the Canadian Forces, Six Sigma may need to be adapted somewhat. The key principles behind the methodology would still need to be respected to assure the integrity of the process – otherwise, it may not provide the successful outcomes hoped for.

One of the primary areas to address in adapting it for the Canadian Forces is the terminology used in the Six Sigma model. There may be reluctance to Six Sigma, simply because it originated in business. For example, the name of the initiative itself may not

[223] *Ibid*, 24-29.
[224] Snee, "Weave Six Sigma…," 69-72.

suit the military way. In their book, *The Six Sigma Way*, Pande et al state, "You don't have to call it Six Sigma to be a Six Sigma organization."[225] They reiterate that the system, the methods, and the commitment to quality are more important than the name given to the program.[226] The Department could chose to use "Warrior Quality" or "The Military Quality Initiative" or any other more palatable title. It is not the name that counts, but the fruit of its application.[227]

Similarly, the use of the term "customer" may not resonate well with military personnel. Certainly those in the medical community prefer to use "patient." Others may choose to use "client", or "soldier," or any other term that describes the recipient of the product or service. What is important is that the "customer" be clearly defined at the onset of the Six Sigma project.

Planners may prefer to incorporate the DMAIC process into the current Operational Planning Process, particularly when dealing with the quality of military operations, such as a program to reduce fratricide. There may be an opportunity to utilize isolated portions of the Six Sigma approach, and there are likely a whole host of other potential adaptations necessary to facilitate a successful implementation for the Canadian Forces. Without doubt, innovative military minds will seek out ways to best utilize the concepts to meet the organization's needs.

[225] Pande, *The Six Sigma Way*, 40.
[226] *Ibid*, 40.

CONCLUSION

Leaders of large organizations such as the Canadian Forces are expected to manage a multitude of complex systems and processes that can malfunction without warning leading to devastating consequences. They need to be capable of managing this complexity in a logical, structured fashion while dealing with an increasingly volatile environment. Senior Officers are constantly challenged by ordinary citizens, politicians, media conglomerates, and other groups promoting special interests; they are submerged in information, much of it unhelpful and distracting; and they are forced to make critical decisions in ever-shorter time frames and to act at an even faster pace.[228] The same can be said about individual sailors, soldiers, and air personnel, who in a wartime or conflict scenario must make split second decisions to fire powerful weapon systems while considering the multitude of laws, values, regulations, policies, procedures and rules of engagement imposed upon them. Whenever things go wrong, whether due to a decision or non-decision, a faulty system, or an individual or systemic failure, the "citizen-customer" may question the relevance of the Canadian Forces, and the ability of its leaders to manage such a complex organization.

To maintain relevance and provide an effective and efficient service in support of the government and the citizens of Canada, the Canadian Forces requires a systematic approach to quality improvement. This paper has demonstrated that the application of a

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[227] Jones, "Understanding Six Sigma," 24.
[228] Homer-Dixon, *The Ingenuity Gap*, 328.

Six Sigma approach to quality improvement can significantly contribute to the Canadian Forces efforts to provide a service that is effective, efficient, and customer-focused. Additionally, adopting a Six Sigma approach to military operations and training may in fact help to reduce the risk of fratricide. Soldiers such as Sergeant Marc Léger and Specialist Pat Tillman deserved a better fate.

Six Sigma was introduced by Motorola in the 1980s to help produce processes that lead to zero defects.[229] Six Sigma is not a fad - it builds on many of the most important management ideas and best practices of the past century, creating a new formula for 21st century organizational success.[230] Six Sigma is not about theory, it's about action.[231] It's about engaging the people who perform the work to determine why performance levels are not as good as they should be and to create the policies, procedures, and work practices that will ensure complete customer satisfaction.[232] Six Sigma is about creating a culture where quality is built into every facet of the organization.[233] Six Sigma is far more than just another novelty concept. It is a major innovation in terms of the management of quality.[234]

There is an opportunity to incorporate Six Sigma quality in many functional areas of the Canadian Forces, from corporate support activities to war-fighting. A structured and gradual approach to implementing the methodology, taking into consideration the

[229] Mohamed Zairi, "Six Sigma: Another Irritation or a Blessed Addition for Better Management?" *The TQM Magazine* 14, no. 5 (2002): 273-74.
[230] Pande, *The Six Sigma Way*, 3.
[231] *Ibid,* 3.
[232] Larson, *Demystifying Six Sigma*…, xiii.
[233] Pande, The Six Sigma Way, 3.
[234] Anonymous, "A Revealing Study of Six Sigma," 34-36.

need to respect change management principles, will contribute to a successful Six Sigma deployment. Six Sigma may not be the Holy Grail for achieving quality in all aspects of the Canadian Forces, but as Homer-Dixon so eloquently states:

> As our world becomes increasingly complex and fast-paced, we will need more high-reliability organizations to manage our air traffic control systems, communication and energy grids, financial systems, military and security organizations, and our natural resources and environment. In the end, we appear to rely more and more on luck to avoid serious failures of the complex systems we have created and depend upon. But in an increasingly complex world, with proliferating unknown unknowns, it would be seriously imprudent to assume that luck will always be there when we need it.[235]

[235] Homer-Dixon, The Ingenuity Gap, 187.

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