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A business process change framework for examining the implementation of six sigma: a case study of Dow Chemicals

Jaideep Motwani Ashok Kumar Jiju Antony

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Jaideep Motwani, Ashok Kumar and Jiju Antony

The authors

Jaideep Motwani and **Ashok Kumar** are Professors of Management, Department of Management, Seidman School of Business, Grand Valley State University, Grand Rapids, Michigan, USA.

Jiju Antony is a Senior Lecturer and Director of Six Sigma Research Group, Division of Management, Caledonian Business School, Glasgow Caledonian University, Glasgow, UK.

Keywords

Quality programmes, Business process re-engineering, Change management

Abstract

Dow Chemical's implementation of six sigma is a well-documented success story. In a short course of about three years, Dow's six-sigma program has surpassed most expectations and goals of strategic and financial performance. Currently, the Dow's program has registered an impressive $1.5b savings since 1999. Furthermore, the program has been very effective in creating an environment for positive, powerful cultural change that is consistent with Dow's lofty global and human objectives. In this paper, a business process change framework is used to examine the factors that facilitated or inhibited the success of six-sigma quality efforts at the Dow Chemicals Company. The data for this study were obtained through interviews, questionnaire survey and archival sources. This work is expected to serve as a basis for evaluating the nature of the impact that six sigma implementation practices would have on a firm's performance.

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Introduction

The six-sigma philosophy is a quality-focused program that requires process design that can accept twice the normal variation of ±3 sigma in a process, even if the process mean shifts by as much as ±1.5 sigma. Thus, the six-sigma approach to quality ensures that a maximum of 3.4 parts per million are defective in each step of the process (Kumar and Gupta, 1993).

The six-sigma concept addresses quality in all aspects of the business: products and services, manufacturing, administration, and operations. When Motorola first introduced six sigma, they combined the following key ingredients:

- a primary goal of total customer satisfaction;
- common, uniform quality metrics for all areas of the business;
- identical improvement rates for all areas of the business measured on one scale;
- goal-directed incentive for managers and employees; and
- coordinated training in reasons for these goals and ways to achieve them (Kumar and Gupta, 1993).

They went on to define the six-sigma quality system as collective plans, activities, and events designed to ensure that products, processes, and services will satisfy customer needs. In summary, six sigma is a customer-focused approach to business that provides an overall framework for quality management.

In this work, we discuss a successful six-sigma implementation experience at a world-class company. Specifically, we examine the factors that facilitated and inhibited the success of six-sigma quality efforts at the Dow Chemicals Company. We first present a published literature overview of six sigma and how several different companies use six-sigma methods to enhance employee participation and improve plant quality. Next, we outline strategic reasons for implementing six sigma and how it relates to Dow's overall corporate objective and operation's strategy of continuous improvement. Prior to implementing six sigma, the company had successfully implemented several total quality management initiatives. The differences between TQM and six sigma are summarized in Table I.

According to a senior management, "the repeated, disciplined application of the master strategy on project after project, where the projects are selected based on key business objectives, is what will drive dollars to the bottom line, resulting in impressive profits." In early 1999, more than 300 executives attended Six Sigma Academy's leadership training program. As part of defining what six sigma would look like at Dow, the

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Table I TQM vs six sigma

TQM	Six sigma
A functional specialty within the organization	An infrastructure of dedicated change agents. Focuses on cross-functional value delivery streams rather than functional division of labor
Focuses on quality	Focuses on strategic goals and applies them to cost, schedule and other key business metrics
Motivated by quality idealism	Driven by tangible benefit far a major stockholder group (customers, shareholders, and employees)
Loosely monitors progress toward goals	Ensures that the investment produces the expected return.
People are engaged in routine duties (Planning, improvement, and control)	"Slack" resources are created to change key business processes and the organization itself
Emphasizes problem solving	Emphasizes breakthrough rates of improvement
Focuses on standard performance, e.g. ISO 9000	Focuses on world-class performance, e.g. 3.4 PPM error rate.
Quality is a permanent, full-time job. Career path is in the quality profession	Six Sigma job is temporary. Six Sigma is a stepping-stone; career path leads elsewhere
Provides a vast set of tools and techniques with no clear framework for using them effectively	Provides a selected subset of tools and techniques and a clearly defined framework for using them to achieve results (DMAIC).
Goals are developed by quality department based on quality criteria and the assumption that what is good for quality is good for the organization	Goals flow down from customers and senior leadership's strategic objectives. Goals and metrics are reviewed at the enterprise level to assure that local sub-optimization does not occur
Developed by technical personnel	Developed by CEOs
Focuses on long-term results. Expected payoff is not well-defined	Six Sigma looks for a mix of short-term and long-term results, as dictated by business demands

Source: Pyzdek (2001)

executives set specific goals for the program and initially selected two businesses for pilot six sigma initiatives that were sure to provide good returns. But the pace of deployment changed dramatically when the results of these initial projects became apparent a few months later. "We realized that this was not something we wanted to do as an evolution," a senior management stated. "It was going to be a transformation. Everyone was going to come to the line and do it quickly. For us, six sigma is more than a methodology and a tool set. It is also a mindset that enables us to change the way we work by making it more data-driven. Six sigma takes us away from intuition-based decisions – what we think is wrong, to fact-based decisions – what we know is wrong" (Ellis, 2001).

This paper can be used as a framework for companies interested in becoming familiar with the six-sigma philosophy as a means of strengthening their own quality programs. By describing the basic foundation for six-sigma implementation, the cultural change within an organization when adopting this program, and the challenges or barriers that can be expected along the way, this paper acts as a good reference for organizations intending to pursue such a quality program.

Review of literature

The literature section comprises two parts. First, we define and discuss how various companies are implementing six sigma within their organizations (See Table II). Then we propose a theoretical framework for examining six-sigma implementation at our case study company.

Many industries have used six-sigma programs as a way to cut costs, improve cycle time, reduce defects and increase customer satisfaction. GE, for instance, uses six sigma to improve performance and product yield by reducing the number of defects inherent in the processes and materials used to produce them (Trotter, 1999). GE relies on a formal methodology of measuring, analyzing, improving and then controlling the processes, in order to remove obstacles critical to customer satisfaction criteria, such as improved product-to-market times (Bolz, 1998).

Allied Signal uses six-sigma process as a foundation for continuous improvement (Harrold, 1999). In addition to the traditional statistical measurement of quality offered by six sigma, Allied Signal applies this quality concept in a different way as well. They use it as a rally cry throughout their facilities to stress the importance of process improvement. Six sigma helps them define areas

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Table II Approaches to six sigma

Corporations	Six sigma approaches/strategies used
Crompton Corporation	Six sigma at Crompton Corporation involves three basic approaches: strategic (continuous improvement of any process), leadership (aligning the strategic effort with the business plans in order to solve pressing problems) and operational (advanced proven tools and financially focused problem solving with teamwork and statistical methods)
Dow Chemicals	In addition to the measure, analyze, improve and control methodology, Dow's six sigma process includes customer loyalty and leverage as two key factors
Du Pont	At Du Pont, six sigma is an overall business process change journey focusing on improving everything they do. It is built on the technology of statistical analysis, follows the methodology of DMAIC, is managed by the line organization, is top leadership driven, develops the people, and focuses on the customer. The deployment of six sigma has touched all 18 strategic business units and regions. The senior leadership of each unit sets goals and then selects a champion who helps to develop projects. Black belts are then picked for each project and sent for intensive training, during which the projects are initiated. The pilot unit chosen to test the six sigma program is selected based on its interest in the methodology. Those units that have the biggest self-identified need drive the sequence of implementation in the other business units
General Electric	GE views six sigma as an all-encompassing quality initiative that is used to define, measure, analyze, improve and control (DMAIC) processes of all kinds
Huntsman	The following three major objectives were established for six sigma at Huntsman: (1) to continue the implementation of improvement projects that provide the most return in meeting strategic objectives; (2) to grow the influence of six sigma in the overall organization through green belt training; and (3) to firmly entrench a process management system within the businesses that guides the utilization of resources to best meet customer needs
Motorola	Following a common six sigma methodology (measure, analyze, improve and control) Motorola began its journey of documenting key processes, aligning processes to critical customer requirements and installing measurement and analysis systems to continuously improve the process

Sources: Challener (2001), Chowdhury (2003), Van Arnum (2003)

their customers consider "critical to quality." By concentrating quality efforts in these areas, Allied has been successful in reducing costs, shortening cycle time, and increasing speed to market (*Industry Week*, 1998).

Raytheon Corporation is using six sigma as a means to reduce defects, and instill continuous improvement philosophies throughout the organization. Raytheon's six-sigma success is attributed to eliminating non-value added work, reducing defects, simplifying processes, reducing variation, and looking for reusable solutions. This enables them to respond more quickly to customer's needs, which results in improved customer satisfaction, competitive advantage, profits, and growth (Raytheon, 1999).

As worker motivation is very important in successful implementation of quality programs, another area of literature research was related to motivation of line-workers. The literature suggests three methods of increasing employee motivation. The first is incentive-based compensation, the second employee ownership plans, and the third implementation of work-based teams. When using any motivational plan, it is extremely important to keep employees informed of how their cost savings are being utilized for the benefit of the company.

The literature suggests that the most common method of capturing a sense of ownership is through employee stock ownership plans or ESOPs (NCEO, 1996). Under such plans, employees receive stock based on some form of incentive program. According to Oliver (1996), these programs work best when compensation is based upon team accomplishments. To reward the individual, in the egalitarian union environment, less remunerative, but highly visible awards such as plaques and coffee mugs may be sufficient (Schuster and Zingheim, 1992).

A different approach, used by Chrysler, is to define many different responsibilities for each person on the continuous improvement team, and then differentiate their pay scale based upon responsibility (Foundation for Enterprise Development, 1996). Although practical, this approach contradicts one school of thought that suggests the teams should be loosely structured to facilitate maximum employee participation (Jones and Beyerlein, 1999). In summary, it appears the correct strategy is dependent upon the level of participation management wishes to create.

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Theoretical framework

Since six-sigma implementation has come to involve changing the business processes of companies, we felt that business process change (BPC) theory may prove useful in explaining the outcomes of our case study (Luo and Tung, 1999). According to Kettinger and Grover (1995), any significant business process change requires a strategic initiative where top managers act as leaders in defining and communicating a vision of change; an organizational environment willingness to learn; culture readiness; balanced network relationships; technology leveragability and knowledge sharing; prescribed process management and change management practices. Process and change management practices, along with the change environment, contribute to better business processes and help in securing improved quality of work life, both of which are requisite for customer success and ultimately, in achieving measurable and sustainable competitive performance gains (Drago and Geisler, 1997). The individual components of the framework (shown in Figure 1) are applied to the subsequent case analysis to determine if they facilitate or inhibit the success of six sigma.

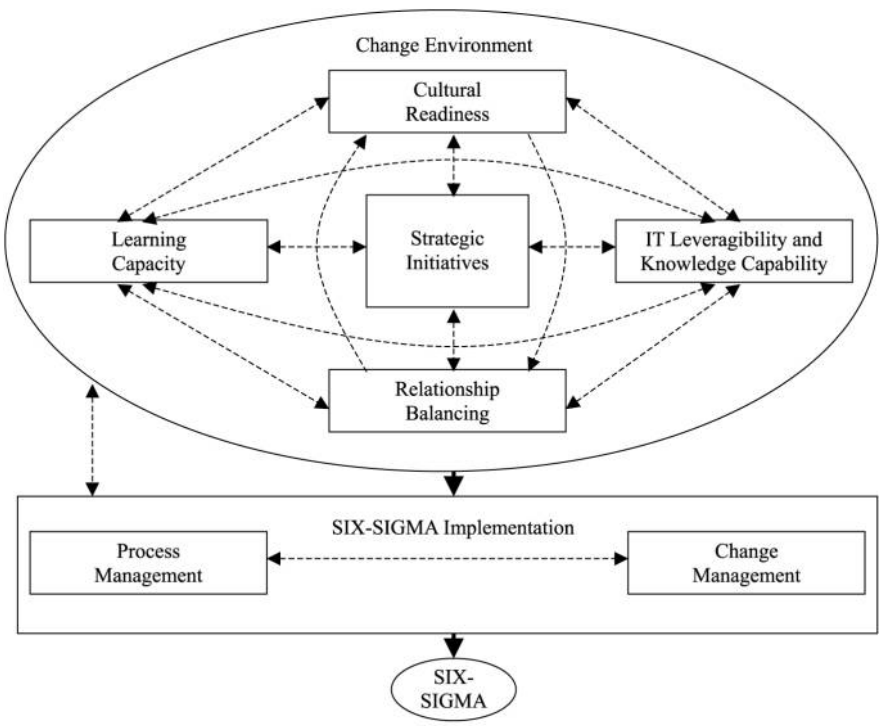
Methodology

A case study approach was employed to conduct the research. Data were collected primarily through interviews, observations, and archival sources. Interviews were conducted with executives who were familiar with the six-sigma implementation progress.

Archival documentation was the third major source of data used in the research. Feasibility studies, reports, memos, minutes of meetings, proposals, newspaper articles, and books that were available were reviewed and the contents analyzed. These documents were collected and analyzed to identify and/or validate data.

During the data collection, special attention was given to ascertaining whether evidence from different sources converged on a similar set of facts. Guidelines in the existing literature on the enhancement of retrospective data accuracy were followed in the process of data collection. When all the evidence had been reviewed, and after an initial case study narrative was documented, the factual portion of the case study was reviewed by the major informants in the company. Such a review was not only a minimal procedure for validating the data collection process, but also a courtesy to those who had co-operated with the research.

Figure 1 Theoretical framework for six sigma implementation



Source: Adapted from Kettinger and Grover's model of BPC Management (1995)

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Case analysis

Brief background of case study company

The Dow Chemical Company, at just over 100 years old, is widely recognized as a technology-based manufacturing business. The company's ambition is to grow better and bigger by re-defining itself as a solutions-oriented science and technology company. Six sigma is a key accelerator of that transformation.

With annual sales of $28 billion (USD), Dow serves customers in more than 170 countries and a wide range of markets that are vital to human progress, including food, transportation, health and medicine, personal and home care, and building and construction, among others. Dow is committed to the principles of sustainable development, focusing on delivering Triple Bottom Line results – an approach that measures success by economic prosperity and environmental stewardship and corporate social responsibility. The company has approximately 50,000 employees around the world, 208 manufacturing sites in 38 countries and supplies more than 3,200 products.

Constructs: definition and analysis

This section discusses each construct of the research model (Kettinger and Grover, 1995). Consistent with the research objectives, specific questions were asked concerning each construct. The research findings of how the case study views and incorporates these constructs are also discussed below.

Construct 1. Strategic initiatives

Process change typically begins with strategic initiatives (often included in the corporate strategic plan) from the senior management team (Kotter, 1995). These could be a reaction to a need (e.g. company's inability to provide adequate customer service) or a proactive push to leverage potential opportunities (Earl, 1994). Evidence also exists that strategic change, and arguably process change, is often incremental, informal, emergent, and is based on learning through small gains (Mintzberg and Waters, 1985) versus being revolutionary and radical.

Throughout the early 1990s, Dow employed a number of measures to streamline and improve its competitive position. Value-based management tools were instituted. Quality performance mechanisms were put in place and re-engineering practices were implemented. In 1994, the company refocused and re-shaped its strategy. The result of this effort was the Strategic Blueprint. Following the development and implementation of the Strategic Blueprint, Dow continued its improvement journey. Global Workstations established a communications pipeline that allowed all employees around the world to share a common computer system, thereby accelerating the pace and quality of communications. Through this period, Dow also implemented a People Success System for the development and growth of its human resources, established a Leadership Development Network to build on leadership skills and align the organization. The company also instituted Growth Acceleration Initiatives to place increased focus on value growth and it launched Strategic Performance Measures to track company performance against key metrics.

While the productivity measures implemented in the 1990s established strong competitive advantages for Dow, company leadership had higher aspirations. Dow leadership's vision extended beyond the role of leadership in the chemical industry and extended to business excellence. Dow set its corporate aspirations purposefully high. The company announced its intention to grow at rates that exceed the industry average without skipping a beat in terms of productivity. The drive toward business excellence was established to accelerate the implementation of business strategy by aligning all the company's businesses, functions, geographies and sites to corporate aspirations; enhancing focus on the marketplace, and ensuring the disciplined application of key processes to accelerate value growth.

In late 1998, Dow leadership embarked on a search for an enabler that would drive the company to the next level of productivity, performance and value. Leadership teams visited a number of top tier global companies, holding discussions on the latest ideas and trends in productivity and improvement. The search led to six sigma.

Dow's implementation began by taking a four-month hiatus to formulate a breakthrough implementation strategy. Within the context of this planning, a number of key decisions were made that set apart Dow's implementation of six sigma from that of others. One decision was that six sigma at Dow would be integrated into the business strategies of the company rather than being relegated to a corporate role. Many quality programs of the past that were relegated to corporate roles were plagued with responsibility but little authority. In effect, this decision added vigor to Dow's implementation of six sigma by placing accountability for results directly on the shoulders of the business leaders of the company.

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2. Learning capacity

The major goal of learning is to provide positive outcomes through effective adaptation to environmental changes and improved efficiency in the process of learning (Guha *et al.*, 1997). Adaptation involves making appropriate responses to technological changes and learning from other organizations that have achieved the best practices in the industry (Freeman and Perez, 1988). Increased efficiency can come from "learning by doing" (Arrow, 1962) and accumulation of knowledge through cross-functional interfaces (Adler, 1990). Learning can also be brought about by scanning external information (Guha *et al.*, 1997). This can come from organizational employees who constantly review the environment for new developments and opportunities (technology gatekeepers), consultants who span the boundary between the environment and the organization (boundary spanners), and from customers.

Dow's values represent the cornerstone of how Dow works and behaves as a company. One of these values, outside-in-focus, is critical to the company's future growth objectives. Dow believes its growth comes from looking for opportunities through the customers' eyes. Focusing on customer loyalty is a way to systematically gather customer input, ensuring that our business strategies are grounded by information from the market. By taking the outside-in approach, we are validating that our business efforts are focused on the things that matter most to our customers.

The application of customer loyalty to Dow's implementation of six-sigma is much more than lip service and good intention. Up to 25 percent of all six-sigma projects are focused on driving a customer loyalty differential for Dow. The Dow focus on customer loyalty is based on an understanding what the customer states is important and the fact that a business can objectively derive a measurable change in competitive advantage based on customer loyalty metrics. The customer loyalty pyramid provides the framework for the development of the customer loyalty process from qualifiers, through essential and defining characteristics and on to the drivers of customer loyalty. Moving a customer from being satisfied to being loyal can create powerful, sustainable business impact. Dow has implemented a process model that drives this critical transformation.

In addition, Dow undertook a diligent study of best practices of six sigma. The study looked at the implementations of best-in-class six-sigma practitioners in order to identify key success factors and gaps. From this study came numerous best practices. Additionally gaps were identified that were employed to differentiate Dow's implementation of six sigma. Specifically, these gaps were customer loyalty and leveraging. Loyalty and leveraging processes and skills are embedded in Dow's six-sigma black belt curriculum and are promoted widely throughout the company

3. Cultural readiness

Organizational culture facilitates (or inhibits) the integration of individual learning with organizational learning by influencing the organization's ability to learn, share information, and make decisions (Kilman *et al.*, 1986). According to Guha *et al.* (1997), leadership (top management) support or change agents (e.g. BPC team) may be considered important prerequisites for business process change. Open communication and information sharing can promote a common culture and innovative behavior in the organization. So also can cross-functional training and personnel movement within the organization (Guha *et al.*, 1997). The Dow leadership team traveled to Scottsdale, Arizona to meet with the Six Sigma Academy in early 1999. Following a series of meetings, two businesses within the company implemented six sigma. In a matter of months, the first six-sigma projects began to prove the promise of the methodology. Late in the summer of 1999, Dow leadership made a bold commitment, expanding the implementation to all its businesses and functions around the world. To lead the implementation of six sigma at Dow, Kathleen Bader was named to the post of Executive Vice President for Quality and Business Excellence. Under the leadership of Kathleen Bader, the "Staircase of Change Leadership" was employed to develop an implementation designed to drive change in a revolutionary, yet sustainable, manner. Each successive step in this staircase builds upon the previous step, forming a solid foundation for change leadership. The steps in this staircase include:

Vision. Dow's stated vision for six sigma is: "Dow will become recognized and lauded as one of the premier companies of the 21st century, driven by an insatiable desire to achieve a six-sigma level of performance and excellence in all that we do." Additionally, the Dow vision for six sigma was cast in the company's 1999 annual report to shareholders. In the letter to shareholders, the company declared: "We expect six sigma to elevate our company to an entirely new level of operation performance, delivering $1.5 billion in EBIT cumulatively by 2003 from the combined impact of revenue growth, cost reductions, and asset utilization."

Values. Dow widely communicates its corporate values – integrity, respect for people, unity,

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outside-in focus, agility and innovation – encourage all employees to honor the relationships, which make Dow successful, and to see the world through the eyes of those whose lives that are affected by the company. The implementation and the methodology six-sigma ties to and directly supports these values.

Attitude. Early in the implementation, it was realized that six sigma was more than an extraordinary methodology and tool set for quality improvement. In its highest form, six sigma represents a mindset change that focuses on results, accountability, and data-driven decision making. In the environment of a large global corporation the unified, passionate attitude of leadership is essential to effective change. According to Kathleen Bader: "Visionary leadership is rarely accidental. It is an attitude that imposes accountability, inaugurates change, inspires belief, invokes commitment, and induces results."

Language. The soul of attitude is evidenced in language. The implementation of six sigma utilizes its own terminology. Utilizing the common language of six sigma was instituted as a leadership practice. Additionally, leadership was encouraged to utilize positive, solutions-oriented language to signal strong support for six sigma at Dow.

Behaviors. A listing of behaviors was communicated throughout the company in a variety of message forms including 34 road shows that took place at Dow sites around the world. These behaviors included: adopting an intolerance for variation, measuring inputs not just outputs, demanding measurement and accountability, requiring sustainable gains, delivering on customer satisfaction to build loyalty, and leveraging for competitive advantage. The road shows, led by Kathleen Bader, sent a clear signal for expected change from six sigma at Dow.

In sum, the top management felt that the best way to tackle problems with six-sigma implementation was through increased communication, motivation and education. For example, when six sigma was first launched at Dow, as a part of the communication plan, slogans such as "show me the data" appeared on internal mail and other communication outlets. The aim was to communicate the new management style based on facts and data.

4. Information technology leverageability and knowledge-sharing capability

The role of IT in the business process change project could be either dominant or as an enabler. Evidence suggests that IT-led projects often fail to capture the business and human dimensions of processes, and are likely to fail (Markus and Keil, 1994). A case is often made for the socio-technical design approach that suggests a mutual, bi-directional relationship between IT and the organization (Hoplin, 1994; Mumford, 1994). Such an approach recommends synergy between the business, human and IT dimensions of an organization and could be promoted through cross-functional teams.

Leveraging is defined as the effective multiple implementation of demonstrated best practices. Breakthrough quality, coupled with Dow's unique ability to instantaneously transmit a six-sigma solution from Texas to Terneuzen to Taiwan turns ideas into impact on the bottom line. Breaking down silos and unleashing the power of leveraging across every Dow business, around the world, is having a multiplier effect on the company's implementation of six sigma.

There are three levels of leveraging six-sigma best practices that exist within Dow. First, leveraging takes place within individual businesses and functions. The next level of leveraging is across businesses and functions. Big company leveraging projects offer huge potential in terms of payoff because big company projects span the entire global organization. To establish a leveraging mindset, Dow has developed tools and processes that enable the acceleration of leveraging. Leveraging is an integral component of black belt training at Dow. Additionally, Dow has established a database that captures a wide range of six-sigma project information. Within this database, key word searches and flags that readily identify projects with leverageable components are commonly used. Furthermore, Dow has established leveraging champions within each of its businesses. The purpose of these leveraging champions is to data mine for leveraging opportunities and continually promote the idea of leveraging throughout the company.

Lastly, Dow wanted to distinguish its practice of six sigma beyond a focus on DMAIC (define-measure-analyze-improve-control methodology of six sigma) by incorporating linkages to those strategic drivers that are at the center of focus for the company. The first of those drivers is a concentrated emphasis on six-sigma linkage to the technology of leveraging. Throughout the 1990s, Dow instituted a global business model and a single information technology platform. With Dow's integrated business structure, single information systems platform and global technology centers, the company is uniquely qualified to leverage best practices from six sigma.

5. Network relationships

Research indicates that under most circumstances cooperative, interpersonal and group behavior

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results in superior performance (Johnson and Johnson, 1989). In terms of inter-organizational processes, research indicates the benefits of partnering with external suppliers (Crosby, 1994). Organizations that can manage these aspects of competition and cooperation continuously can benefit from employee incentives and controls, as well as instill change more effectively (Guha *et al.*, 1997).

Following the development and implementation of the Strategic Blueprint, the case company continued its improvement journey. Global Workstations established a communications pipeline that allowed all employees around the world to share a common computer system, thereby accelerating the pace and quality of communications. Through this period, the case company also implemented a People Success System for the development and growth of its human resources, established a Leadership Development Network to build on leadership skills and align the organization. The company also instituted Growth Acceleration Initiatives to place increased focus on value growth and it launched Strategic Performance Measures to track company performance against key metrics.

6. Change management practice

Change management involves effectively balancing forces in favor of a change over forces of resistance (Stebel, 1992). Organizations, groups, or individuals resist changes that they perceive threaten them (Guha *et al.*, 1997). It has been suggested that corporate transformation requires a general dissatisfaction with the status quo by employees who have to change (i.e. a readiness to change), a vision of the future, and a well-managed change process. Revolutionary and evolutionary change theorists propose contrasting tactics for accomplishing change (Stoddard and Jarvenpaa, 1995) that vary depending on the type of employee involvement, communication about the change, and leadership nature.

Thus, the pattern of change (formal versus informal), management's readiness to change (i.e. being committed to it, participative in the process, or resistant to it), scope of change (continuous improvement versus radical change), management of change (alleviation of dissatisfaction, top management's vision for change, well-managed process of change, and use of evolutionary versus revolutionary change tactics) are the key constructs in practicing change management (Kettinger and Grover, 1995).

The company followed a structured methodology for managing change. The management of the company was committed to making six sigma a top priority within their business environment. The company established a six-sigma resource commitment. This commitment calls for 3 percent of all employees to be six-sigma black belts. Black belts are expected to fulfill a two-year, full-time commitment to six sigma. The two-year commitment begins when their first project goes into realization. In addition to culture change being facilitated by having 3 percent of all employees as six-sigma black belts, the case company employs numerous other levers to effect cultural change. For example, employee compensation plans are tied to six-sigma results. Top leadership has established an expectation that all employees have at least one personal goal tied to six sigma. Additionally, the company has established an expectation that all of its professional-level employees must be engaged in a successful six-sigma project by year-end 2005.

An example of how change management worked at Dow clearly demonstrates how the company was able to successfully implement six sigma without much resistance. According to Ellis (2001), Dow applied six sigma at one of its plants to find out why employees routinely replaced valves with new rather than recycled valves. The analysis revealed that nobody was accountable for encouraging people to use recycled valves, nor was there any incentive to do so. What's more, employees weren't even aware that recycled valves were available. The solution was to tie valve expenditures to individual cost center budgets. Once the work areas were responsible for the costs of replacing valves, they started using recycled units. The six-sigma team targeted 10 percent return rate on the 2,300 valves used at the facility, but actual results were nearer 100 percent. Now, not only can the cost savings be leveraged as other plants follow suit, the employee responsible for refurbishing the valves – who just happened to be the black belt in charge of the project – knows that his co-workers value his work.

7. Process management practice

Process management is defined as a set of concepts and practices aimed at better stewardship of business processes. It combines methodological approaches with human resource management to improve the outcome of BPC (Guha *et al.*, 1997). Successful process management uses process measurement (use of process metrics, process information capture, improvement feedback loop, and process audit), tools and techniques (e.g. quality control tools, data flow diagrams, CASE tools, and simulation) and documentation (e.g. process flow chart analysis, fishbone and root cause analysis). Evidence also supports the use of team-based structures both for the implementing

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the project and for designing the new processes (Guha *et al.*, 1997).

The strength of the six-sigma methodology will change corporations through an evolutionary process. However, the drivers for change facing the case company created an urgency that wouldn't wait for evolution. What was needed was transformation. As with any plan of attack, a detailed and rigorous strategy is required.

The six-sigma breakthrough strategy implemented at the company wove together three leading-edge processes. The Stages of Change model as proposed by Dave Ulrich from the University of Michigan suggests that individuals go through four stages of change … from Awareness to Sustaining stages. Through this process, behaviors are first unfrozen. New behaviors are then defined then institutionalized. Finally, the new behaviors are reinforced in the Sustaining phase. The Management of Change bubble chart was also utilized. The components of this chart were synthesized from a number of organizational behavior studies. This chart contains six cultural change elements that must be addressed during implementation of change. The Stages of Change model and the Management of Change model were overlaid against a Managing Implementation plan or MI. MI is based on the concepts of Hoshin Kanri (or Hoshin Planning). The MI plan incorporates vision along with three to five year strategic objectives. Finally, annual objectives result from this plan. Objective metrics to evaluate progress against this plan and clearly identified areas of accountability are critical. The matrix of strategy formed by these three processes set the implementation of six sigma at the case company in motion, in a focused and clear direction.

Lessons and insights

According to the literature, successful application of six sigma involves planning, effort and flexibility. Simply applying another company's plan, problem solving process, team structure, or training package does not ensure success. Based on extensive interviews with the major players involved in six-sigma implementation at Dow Chemicals, here are some reasons why six sigma was successful at this company. These reasons (some unique) provide important lessons and insights for other companies planning to implement six sigma:

- *The value of constancy of purpose* – Dow began its focus on six sigma with top-down leadership endorsement. The power of that endorsement has been sustained and has grown since its implementation began. This "constancy of purpose" sends a clear signal to the entire company about long-term expectations and true cultural change.
- *Financial rigor* – Dow instituted business rules and established a team of trained financial analysts to review and validate financial benefits from its six sigma projects. Applying financial rigor offers transparency and credibility to the company's implementation of six sigma.
- *Data capture and knowledge management* – six sigma drives a data-based decision making process. In order to capture and leverage knowledge, a flexible and user-friendly database must be established. Dow has invested significantly in the construction and maintenance of its database system for six sigma. This investment is paying substantial dividends in terms of knowledge capture for leveraging and tracking of project metrics for ongoing improvement.
- *A way to do work … not additive* – many falsely believe that six sigma is additive or parallel. In other words, six sigma is often viewed as something else that the organization has to do rather than the way in which work is done. It is essential to clearly position six sigma as the way in which work is done. Most business roles involve solving problems and closing the gap between reality and a desired state. Six sigma is a methodology, a tool set and a mindset that is ideally suited for solving problems. Used properly, six sigma accelerates business strategy.
- *Pipeline conundrum* – reflecting back on its decision to implement via rapid transformation, Dow would consistently say that the approach it took was the right one at the right time. One challenge of implementation through rapid transformation is that it is possible to deplete the project pipeline. Keeping a robust pipeline is essential to maintaining and building momentum for six sigma implementation. Time spent up front in creating a project pipeline would be well spent.

Conclusion and future directions

Full-scale implementation of six sigma at Dow began early in 2000. As many as four training waves, each containing approximately 200 black belts, have been conducted since the full-scale launch. Each business and function within Dow has a business champion to drive the implementation. Furthermore, local champions are in place to make certain that black belts are supported at the local level with viable project

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charters and barrier-breaking support. Process owners are also identified to make sure that control plans stay in place and gains are sustained for the long term. The company aims for savings of $250,000 per project, but as a senior manager said, "That dollar amount isn't written in stone. We have projects that produced a dollar savings of less than that, but they resulted in other benefits too, for example, a customer loyalty benefit or reduced cycle time".

The company has also established a six-sigma resource commitment. This commitment calls for 3 percent of all employees to be six-sigma black belts. Black belts are expected to fulfill a two-year, full-time commitment to six sigma. The two-year commitment begins when their first project goes into realization. In addition to culture change being facilitated by having 3 percent of all employees as six-sigma black belts, Dow employs numerous other levers to effect cultural change. For example, employee compensation plans are tied to six-sigma results. Top leadership has established an expectation that all employees have at least one personal goal tied to six sigma. Additionally, the company has established an expectation that all of its professional-level employees must be engaged in a successful six-sigma project by year-end 2005.

There is an old maxim that goes: "Nothing succeeds like success." In its implementation of six sigma, Dow has exceeded each one of its financial results targets. Dow's six sigma implementation is generating significant financial results and is effectively driving positive, powerful cultural change. Dow Chemicals, which implemented six sigma on a corporate-wide basis in 2000, achieved its target of $1.5 billion in cumulative EBIT (earnings before interest and taxes) gains by the end of 2002, one year ahead of the scheduled target date, says Tom Gurd, vice president, quality and business excellence at Dow Chemical (Van Arnum, 2003). The company currently has over 3,000 projects underway using six sigma, with 150 master black belts, 1,400 active black belts and 2,500 green belts. Overall, Dow has had 40 percent of its workforce engaged at some level in at least one six sigma project, and by 2005, it hopes to have its entire workforce of roughly 50,000 engaged in six sigma.

References

Adler, P. (1990), "Shared learning", *Management Science*, Vol. 36 No. 8, pp. 938-57.

Arrow, K. (1962), "The implications of learning by doing", *Review of Economic Studies*, Vol. 29, pp. 166-70.

Bolz, S. (1998), "A six sigma approach to competitiveness", *Transmission & Distribution World*, Vol. 50 No. 8, pp. 18-19.

Challener, C. (2001), "Six sigma: can the GE model work in the chemical industry?", *Chemical Market Reporter*, Vol. 260 No. 3, pp. FR6-FR9.

Chowdhury, S. (2003), "Design for quality", *Executive Excellence*, Vol. 20 No. 4, p. 12.

Crosby, P. (1994), *Completeness: Quality for the 21st Century*, Plume Books, New York, NY.

Drago, W. and Geisler, E. (1997), "Business process re-engineering: lessons from the past", *Industrial Management & Data Systems*, Vol. 97 No. 8, p. 297.

Earl, M. (1994), "Viewpoint: new and old business process redesign", *Journal of Strategic Information Systems*, Vol. 3 No. 1, pp. 5-22.

Ellis, K. (2001), "Mastering six sigma", *Training*, Vol. 28 No. 12, pp. 30-5.

Foundation for Enterprise Development (1996), "US Department of Labor Office of the American Workplace: Chrysler Corporation Company Profile", available at: www.fed.org/library/articles/labor/a_m/Chrysler_Corporation.html, p. wwwfedorg/library/articles/labor/a_m/Chrysler_Co

Freeman, C. and Perez, C. (1988), "Structural crisis of adjustment: business cycles and investment behavior", in Dosi, G. *et al.* (Ed.), *Technical Change and Economic Behaviour*, Pinter, London.

Guha, S., Grover, V., Kettinger, W. and Teng, J. (1997), "Business process change and organizational performance: exploring an antecedent model", *Journal of Management Information Systems*, Vol. 14 No. 1, pp. 119-54.

Harrold, D. (1999), "Designing for six sigma capability", *Control Engineering*, January, pp. 62-70.

Hoplin, H. (1994), "Integrated advanced information systems and technology in future organizations", *Industrial Management & Data Systems*, Vol. 94 No. 8, pp. 17-21.

Industry Week (1998), "Six sigma secrets", Vol. 247 No. 20, pp. 42-3.

Johnson, D. and Johnson, R. (1989), *Cooperation and Competition: Theory and Research*, Interaction, Edina, MN.

Jones, S. and Beyerlein, M. (Eds) (1999), "Abstract case studies: developing high-performance work teams", Center for the Study of Work Teams, North Texas State University, Denton, TX, available at: www.workteams.unt.edu/edu/cases2.htm (accessed 9 April).

Kettinger, W. and Grover, V. (1995), "Toward a theory of business process change management", *Journal of Management Information Systems*, Vol. 12 No. 1, pp. 1-30.

Kilman, R., Saxton, M. and Serpa, R. (1986), "Issues in understanding and changing culture", *California Management Review*, Vol. 28 No. 2, pp. 87-94.

Kotter, J. (1995), "Leading change: why transformation efforts fail", *Harvard Business Review*, Vol. 73 No. 2, pp. 59-67.

Kumar, S. and Gupta, Y. (1993), "Statistical process control at Motorola's Austin assembly plant", *Interface*, Vol. 23, March-April, pp. 84-92.

Luo, W. and Tung, A. (1999), "Framework for selecting business process models", *Industrial Management & Data Systems*, Vol. 99 No. 7, pp. 312-19.

Markus, M. and Keil, M. (1994), "If we build it, they will come: designing information systems that users want to use", *Sloan Management Review*, Vol. 35 No. 4, pp. 11-25.

Mintzberg, H. and Waters, J. (1985), "Of strategies deliberate and emergent", *Strategic Management Journal*, Vol. 6 No. 3, pp. 257-72.

Mumford, E. (1994), "New treatment or old remedies? Is business process reengineering really sociotechnical

design?", *Journal of Strategic Information Systems*, Vol. 3 No. 4, pp. 313-26.
NCEO (1996), "Employee ownership and corporate performance", The National Center for Employee Ownership Library, available at: www.nceo.org/library/corpperf.html (accessed 9 April 1999).
Oliver, J. (1996), "Cash on delivery", *Management Today*, August, pp. 52-5.
Pyzdek, T. (2001), "Why six sigma is not TQM" (online), *Quality Digest*, April.
Raytheon (1999), available at: www.raytheon.com/rtis/docs/baldrige/sixsigma.htm, Raytheon Company, Waltham, MA (accessed 1 April).
Schuster, J.R. and Zingheim, E.J. (1992), *The New Pay: Linking Employee and Organizational Performance*, Lexington Books, New York, NY.
Stebel, P. (1992), *Breakpoints: How Managers Exploit Radical Change*, Harvard Business School Press, Boston, MA.
Stoddard, D. and Jarvenpaa, S. (1995), "Businesss process reengineering: tactics for managing radical change", *Journal of Management Information Systems*, Vol. 12 No. 1, pp. 81-108.
Trotter, L. (1999), "Six sigma: driving customer satisfaction in all we do", available at: www.ge.com/edc/dcsixsig.htm (accessed 1 April).
Van Arnum, P. (2003), "Quality focus: the next phase of six sigma", *Chemical Market Reporter*, Vol. 264 No. 8, p. 10.

Further reading

Edwards, D.K. (1996), "Practical guidelines for lean manufacturing equipment", *Production and Inventory Management Journal*, Vol. 37 No. 2, pp. 51-5.
Kettinger, W., Guha, S. and Teng, J. (1995), "The process engineering lifecycle methodology: a case study", in Grover, V. and Kettinger, W. (Eds), *Business Process Change: Reengineering Concepts, Methods and Technologies*, Idea Publishing, Harrisburg, PA.
Velocci, A. (1998), "Pursuit of six sigma emerges as industry trend", *Aviation Week and Space Technology*, Vol. 149 No. 16, pp. 52-9.

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3. A. Lanke, B. GhodratiReducing defects and achieving business profitability using innovative and lean thinking 1026-1030. [CrossRef]
4. E.V. Gijo, Ashok Sarkar. 2013. Application of Six Sigma to improve the quality of the road for wind turbine installation. *The TQM Journal* **25**:3, 244-258. [Abstract] [Full Text] [PDF]
5. Meera Alagaraja, Toby Egan. 2013. The Strategic Value of HRD in Lean Strategy Implementation. *Human Resource Development Quarterly* **24**, 1-27. [CrossRef]
6. Sunil Sharma, Anuradha R. Chetiya. 2012. An analysis of critical success factors for Six Sigma implementation. *Asian Journal on Quality* **13**:3, 294-308. [Abstract] [Full Text] [PDF]
7. Sunil V. Deshmukh, Ashish Chavan. 2012. Six Sigma and SMEs: a critical review of literature. *International Journal of Lean Six Sigma* **3**:2, 157-167. [Abstract] [Full Text] [PDF]
8. S. Karthi, S. R. Devadasan, R. Murugesh, C. G. Sreenivasa, N. M. Sivaram. 2012. Global views on integrating Six Sigma and ISO 9001 certification. *Total Quality Management & Business Excellence* **23**, 237-262. [CrossRef]
9. Roger John Hilton, Amrik Sohal. 2012. A conceptual model for the successful deployment of Lean Six Sigma. *International Journal of Quality & Reliability Management* **29**:1, 54-70. [Abstract] [Full Text] [PDF]
10. Ashish Malik, Stephen Blumenfeld. 2012. Six Sigma, quality management systems and the development of organisational learning capability. *International Journal of Quality & Reliability Management* **29**:1, 71-91. [Abstract] [Full Text] [PDF]
11. A. Chakraborty, M. LeyerDeveloping a framework for Six Sigma in financial service institutions - empirical evidence from expert interviews 799-803. [CrossRef]
12. Payam Hanafizadeh, Elmira Osouli. 2011. Process selection in re-engineering by measuring degree of change. *Business Process Management Journal* **17**:2, 284-310. [Abstract] [Full Text] [PDF]
13. Paulo Augusto Cauchick Miguel, João Marcos Andrietta. 2010. Outcomes from a descriptive survey of Six Sigma management practices in Brazil. *International Journal of Lean Six Sigma* **1**:4, 358-377. [Abstract] [Full Text] [PDF]
14. Ronald Ramirez, Nigel Melville, Edward Lawler. 2010. Information technology infrastructure, organizational process redesign, and business value: An empirical analysis. *Decision Support Systems* **49**, 417-429. [CrossRef]
15. Selçuk Perçin, Cengiz Kahraman. 2010. An Integrated Fuzzy Multi-Criteria Decision-Making Approach for Six Sigma Project. *International Journal of Computational Intelligence Systems* **3**, 610-621. [CrossRef]
16. Anna Sidorova, Oyku Isik. 2010. Business process research: a cross-disciplinary review. *Business Process Management Journal* **16**:4, 566-597. [Abstract] [Full Text] [PDF]
17. Diana Heckl, Jürgen Moormann, Michael Rosemann. 2010. Uptake and success factors of Six Sigma in the financial services industry. *Business Process Management Journal* **16**:3, 436-472. [Abstract] [Full Text] [PDF]
18. Keld Pedersen, Pernille Kræmmergaard, Bjarne Christoffer Lynge, Christoffer Dalby Schou. 2010. Itil Implementation: Critical Success Factors A Comparative Case Study Using The Bpc Framework. *Journal of Information Technology Case and Application Research* **12**, 11-35. [CrossRef]
19. Mohamed Gamal Aboelmaged. 2010. Six Sigma quality: a structured review and implications for future research. *International Journal of Quality & Reliability Management* **27**:3, 268-317. [Abstract] [Full Text] [PDF]
20. Xingxing Zu, Tina L. Robbins, Lawrence D. Fredendall. 2010. Mapping the critical links between organizational culture and TQM/Six Sigma practices. *International Journal of Production Economics* **123**, 86-106. [CrossRef]
21. Satya S. Chakravorty. 2009. Six Sigma failures: An escalation model. *Operations Management Research* **2**, 44-55. [CrossRef]
22. Michael J. Pisani, Randall Hayes, Anil Kumar, Lawrence Lepisto. 2009. Is Six Sigma culture bound? A conceptual model and propositions for further inquiry. *Total Quality Management & Business Excellence* **20**, 1123-1137. [CrossRef]
23. Francis Vanek, Peter Jackson, Richard Grzybowski. 2009. Systems engineering metrics and applications in product development: A critical literature review and agenda for further research. *Systems Engineering* **11**:10.1002/sys.v11:2, 107-124. [CrossRef]
24. Paulo Augusto Cauchick Miguel, João Marcos Andrietta. 2009. Benchmarking Six Sigma application in Brazil. *Benchmarking: An International Journal* **16**:1, 124-134. [Abstract] [Full Text] [PDF]

25. K. K. Chang, F. K. Wang. 2008. Applying Six Sigma methodology to collaborative forecasting. *The International Journal of Advanced Manufacturing Technology* **39**, 1033-1044. [CrossRef]
26. Maneesh Kumar, Jiju Antony, Christian N. Madu, Douglas C. Montgomery, Sung H. Park. 2008. Common myths of Six Sigma demystified. *International Journal of Quality & Reliability Management* **25**:8, 878-895. [Abstract] [Full Text] [PDF]
27. U. Dinesh Kumar, David Nowicki, José Emmanuel Ramírez-Márquez, Dinesh Verma. 2008. On the optimal selection of process alternatives in a Six Sigma implementation. *International Journal of Production Economics* **111**, 456-467. [CrossRef]
28. Ziaul Huq. 2006. Six-Sigma implementation through Competency Based Perspective (CBP). *Journal of Change Management* **6**, 277-289. [CrossRef]
29. J Antony, M Kumar, M K Tiwari. 2005. An application of Six Sigma methodology to reduce the engine-overheating problem in an automotive company. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture* **219**, 633-646. [CrossRef]