

Improve Health and Reduce Healthcare Costs from Pranayam with Six Sigma

Pradeep B. Deshpande

in Association with Louisville Pranayam Group (LPG), Louisville, Kentucky

The members of LPG are profiled at the end of the article.

Pranayam is a set of breathing exercises purported to be effective for a variety of ailments. The exercises involve conscious prolongation and manipulation of breath inhalation, retention, and exhalation. Like Asanas (Yoga Postures) and Meditation, Pranayam is a component of the eightfold yoga path of ancient Indian seer *Patanjali* for the cultivation of the body, mind, and the spirit. This investigation is inspired by the work of Swami Ramdev of Hardwar, India. Pranayam claims a large number of health benefits ranging from reduction in serum sugar level, cholesterol, and body weight, to freedom from urinary, liver, and thyroid problems, hyperacidity, constipation, migraine, and allergies among many others. Swami Ramdev demonstrates how these exercises are done in a video CD available from Divya Yoga Trust (www.divyayoga.com).

Why Pranayam?

- (1) Pranayam appears to be the only method available for exercising internal organs and systems, from nasal systems & sinuses all the way to urinary & GI tracts. For good health, combining exercises for external systems (muscles, joints, etc.) such as Asanas, workouts at a Gym, swimming, walking, etc., together with Pranayam exercises for internal organs and systems appears to make perfect sense.
- (2) The genius of Patanjali, credited with introducing Pranayam around 500 BC, has been endorsed by some very enlightened individuals such as the late Swami Vivekanand. Millions of people in India are now hooked to this form of exercise.
- (3) Medical professionals at the MD Anderson Cancer Center in Houston recently reported on the benefits of Asanas and meditation for breast cancer patients. Pranayam too is a part of the same Yoga System of Patanjali, a source of confidence about the benefits.

- (4) The Pranayam program requires an investment of thirty to forty minutes a day and could bring significant benefits to the practitioner at insignificant one-time costs associated with learning these exercises. A low-cost approach to improving health, such as Pranayam, should not only be of interest from an individual perspective but it could potentially reduce national health care costs in the United States significantly.
- (5) Over his four decades of stay in the United States, the author has carried out extensive studies of the Theory of Rise and Decline of Cultures permitting him in the early nineties to predict the rise of China and India. It is clear Indian contributions to human civilization last time India was on the rise remain unparalleled. With India rising again, consistent with the Theory of Rise and Decline, the author had the sense some in today's India, such as Swami Ramdev, had figured out the intricacies of how Pranayam exercises ought to be performed and also that Pranayam was for everyone and not only for the spiritual growth of the select few as a part of the eightfold Yoga system of Patanjali.

What is Six Sigma?

Motorola pioneered six sigma in the late seventies for improving the performance of linear and static work processes. The writer's work later extended the applicability of six sigma to dynamic and nonlinear work processes in the nineties. It is now possible to assert six sigma is right for any process, manufacturing (discrete parts, continuous, batch) or transactional, static or dynamic, linear or nonlinear. In fact, six sigma is for life and so it is prudent to think, work, and live the six sigma way.

In the context of six sigma, a work process is any activity that consists of a series of steps. Viewed this way, it should be clear, virtually all human activities are work processes and six sigma may be used to assess and

improve the performance of any of them. Since Pranayam too is a work process as we will shortly see, six sigma is the appropriate methodology to study it.

Six sigma is made possible by three fundamental laws of nature:

One: The first natural law, from ancient India, states, "All that we do have causes and effects. Furthermore, the effect of one cause is in turn a cause for another effect. The endless chain of cause and effect is called *karma*". In the context of six sigma, the author has adapted this natural law according to: "For every effect, there must necessarily be a cause (or causes)". The effect represents the outcome of a work process by which its performance is measured and whose performance is sought to be improved. Although the law of cause and effect does not identify what the causes are, it should nonetheless be a source of great comfort for anyone aspiring to assess and improve the performance of work-processes knowing that there are *causes* impacting the outcome. The causes themselves must be found by a disciplined six sigma study. In this work, the effects are the health parameters whose performance is sought to be improved with Pranayam.

Fundamentally, there are three types of causes and their description necessitates access to two other laws of nature:

Two: The second natural law, adapted from the work of German scientist Frederick Gauss (19th Century AD), stipulates the first of these causes. It states "The outcomes of all processes and transactions exhibit a certain amount of inherent variability no matter how well they are designed". In other words, perfection (zero defects) is not in the plan of nature. However, adherence to six sigma principles will ensure that defect levels are as small as they can theoretically be. This natural variability (also called common cause variability) occurs due to a variety of unknown and/or uncontrol-

lable causes and it often follows the familiar bell-shaped curve (normal probability distribution). Although the normal probability distribution is the most common, inherent variability based on other probability distributions is not precluded. The spirit of this natural law is that there is always a certain amount of inherent variability associated with outcomes of work processes due to uncontrollable causes and it follows a specific probability distribution. In our example, patient history denoting hereditary factors and how an individual has evolved from birth to the present time, how we cope with stress, and the physical environment where we live are examples of common causes. If the entire variability in the outcome were due to common causes, then, no improvement via six sigma is possible. Fortunately, such is not the case in most situations.

Three: The third fundamental law adapted from the work of several 20th Century quality control professionals from the United States and Japan (Shewhart, Deming, Juran, and Taguchi, among others) specifies the second and third type of causes. This law states "The inherent variability in the outcomes (effects, also called response variables) of work processes is worsened by causes (called assignable or special causes) that are discoverable. Tracing and then eliminating these causes (type 2 causes), or setting them at proper values (type 3 causes) as appropriate, will return the process or transaction to its natural state". In our example, diet, exercise, and the medicines we take are examples of assignable causes. Thus by holding what's under our control as constant as humanly possible, if we can show the effect of Pranayam on a particular health parameter is far greater than the observed variability in that parameter, then it may be asserted Pranayam improves health. These ideas are clarified in Figure 1.

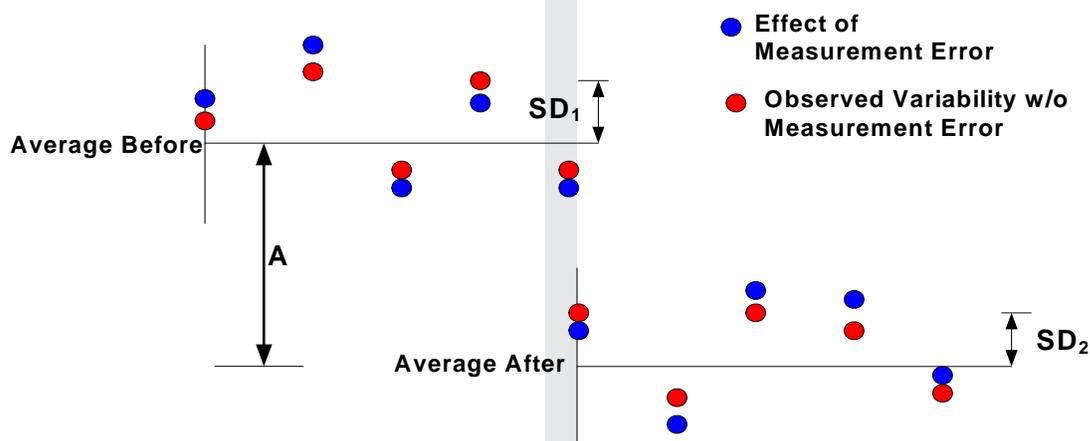


Figure 1. Effect of Pranayam versus Observed Variability & Measurement Error.
For Pranayam to claim benefit, $A \gg SD_1$ and $SD_2 < SD_1$

Application of these natural laws leads to a five-phase, eleven-step methodology for implementing six sigma. In manufacturing and service applications worldwide, diligent application of six sigma has led to extremely few defects, accompanied by high levels of customer satisfaction, improved bottom lines, and globally competitive positions for corporations. Six sigma can make entire nations become or remain globally competitive. An overview of six sigma may be found in Appendix I.

Why Pranayam with Six Sigma?

It is important for the practitioners of Pranayam to follow six sigma principles for the following reasons:

(1) Six sigma emphasizes why inputs under our control (that are the sources of variation in the health parameters) must be held as constant as humanly possible while engaged in the study of Pranayam or else the benefits of Pranayam cannot be accurately assessed.

(2) Benefits from Pranayam must be much larger than the observed variability if we are to claim Pranayam has led to improvement; relying on a single data point before and after to assess the benefit of Pranayam will lead to inaccurate assessment of results (see Figure 1).

(3) Six sigma principles show how measurement systems are validated and also the severe penalties of not validating them.

(4) Six sigma principles caution the practitioner of Pranayam that human systems are nonlinear and so the results will vary from one individual to the next.

(5) Six sigma principles emphasize every human being has a unique common cause variability that depends on heredity factors and how that individual has evolved from birth to the present age and so extreme caution must be exercised when comparing the results of Pranayam of one individual with another.

(6) Six sigma principles emphasize that the population of human beings is heterogeneous and nonlinear and therefore, stratified sampling principles with very large sample sizes must be used to claim generality of Pranayam health benefits.

(7) Six sigma principles teach the practitioner that correlation does not necessarily imply causality. This will help the practitioner ascertain if the benefits seen are really due to Pranayam.

(8) The author has the sense Pranayam will remain confined to yoga enthusiasts unless the benefits are seen demonstrated scientifically (with six sigma). There are millions of six sigma professionals in the United States now. If these folks are convinced and start practicing Pranayam and realize benefits, the message will likely spread to the general population. Then, the impact of Pranayam on national healthcare costs will be seen.

(9) Persons not trained in six sigma, often articulate a problem statement and propose the solution, more or less in the same breath, skipping the numerous steps in between. Six sigma principles teach us not to do that. Every one must follow the five-phase eleven-step six sigma methodology, without skipping any of the steps in a disciplined manner to achieve improvement. Then, there will be fewer faux pas like the 2000 Presidential Elections in Florida.

Convinced that this type of training must be an integral part of higher education, the author is making attempts to motivate colleges and universities here and in India to introduce six sigma training in the curricula. His course at the University of Louisville remains oversubscribed after five annual offerings and now attracts students from all engineering disciplines (except civil engineering). The University Kentucky's Gatton College of Business and Economics in Lexington has introduced mandatory six sigma training in their new and innovative MBA curriculum and we have been retained to provide training. The author and his associates have also introduced six sigma training in several B Schools in India.

Why the Problem under Scrutiny is So Difficult?

A systemic representation of human health in terms of *causes* and *effects* is shown in Figure 2. From a systems perspective, human beings are multivariable and self regulating and they exhibit highly nonlinear behavior. For the benefit of the reader unfamiliar with the terminology, a linear system is one that behaves similarly for identical inputs, while a nonlinear system does not. Thus, a specific medication may cure thousands of an ailment but may prove to be fatal for a select few. Furthermore, the natural variability in health parameters is different from one individual to the next due to heredity factors, unlike that in a manufacturing or service application.

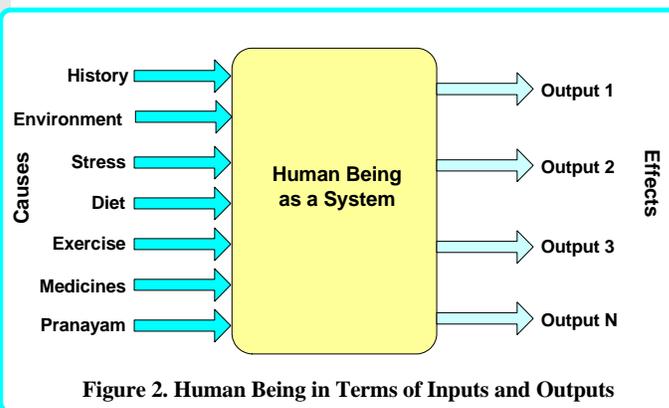


Figure 2. Human Being in Terms of Inputs and Outputs

Finally, the characteristics of human systems change with advancing age. This means what worked today is not guaranteed to work a few years down the line. It is remarkable that despite these complexities, internal con-

trols are able to do as good a job of maintaining certain critical parameters such as body temperature, within desirable ranges.

The Six Sigma Pranayam Program

Swami Ramdev's Pranayam program consists of eight specific exercises. They are:

- | | |
|------------------|-----------------------------|
| 1. Omkar: | Warm up Pranayam |
| 2. Bhastrika: | Inhale-Exhale Pranayam |
| 3. Kapalbhathi: | Exhale-Exhale Pranayam |
| 4. Bahya: | Stomach-In Pranayam |
| 5. Anulom-Vilom: | Alternate Nostrils Pranayam |
| 6. Ujjayi: | Constrict Throat Pranayam |
| 7. Bhramari: | Bumble Bee Pranayam |
| 8 Omkar: | Cool Down Pranayam |

These exercises must be done on an empty stomach, several hours after a meal and so mornings appear to be the best time for them. In the video CD, Swami Ramdev shows the sitting posture for these exercises; comfortable sitting position on a floor or chair and a straight spine.

This paper reports two case studies undertaken for studying the efficacy of Pranayam for improving health with six sigma principles. The first involves the author and the other, a group of nineteen in Louisville. The author trained the Louisville group and the members then practiced Pranayam for three months to assess benefits.

Case Study 1 - Author

Qualitative and quantitative health parameters are the outcomes (*effects*) of the work process. The parameters tracked are outside acceptable ranges leading to health issues. The Problems the author wishes to rectify in his own case are:

1. Constipation
2. Nasal allergies and chronic sinusitis
3. Hyperacidity
4. Serum Sugar and HbA1C Enzyme levels
5. Snoring

It may be informative to elaborate on these problems.

1. Constipation. "I grew up in India basically on a vegetarian diet, rich in roughage and bulk. I came to the United States over forty five years ago and quickly changed to a high protein diet upon arrival. I began to experience constipation problems by the late sixties. In 1982, Dr. Mauricio Salazar, a colo-rectal surgeon in Louisville operated on me for fissures. The situation appeared to improve for the next ten or so years but the problem resurfaced again and seemed to get worse. Dr. Raymond Pierce, a colo-rectal surgeon in Louisville, did a colonoscopy on me in July 2002 and the results were

normal. Dr. Pierce recommended I take a daily dose of metamucil, a fiber supplement, along with a couple of surfak capsules for constipation".

2. Nasal Allergies and Chronic Sinusitis. "We moved to Louisville in 1975 and soon thereafter, sinus allergies began to bother me. Louisville is a fine place to live but it is known for allergies. Dr. Amul Patel, a friend and an ENT specialist, operated on me on March 6, 1995 to remove nasal polyps. The operation appeared to help for a few years but the sinus problems resurfaced. Every few months I would come down with a sore throat or cold which would often lead to sinus infection and Bronchitis. Antibiotics and breathing treatments my friend and family doctor, Dr. Nandlal Yepuri, would prescribe worked but the problem recurred often. Travel on an airplane was uncomfortable because of ear pain. On July 12, 2001, Dr. John G. Riehm, an Allergy Specialist with an undergraduate electrical engineering degree from the University of Louisville, diagnosed my problem as chronic sinusitis on the basis of an MRI and prescribed a daily dose of an antihistamine and antibiotics for the active sinus infection. A couple of years ago, I developed patches of skin rashes which motivated me to seek advise last year from Dr. George Sonnier, a professor of dermatology at the University of Louisville. After skin cancer and other tests, Dr. Sonnier felt that the cause was either unknown or one of the medications I was taking was responsible for the rashes. He suspected Accupril, a blood pressure medication I had been taking for several years but he wasn't comfortable recommending a change at the time of my last appointment".

3. Hyperacidity. "About fifteen years ago, I began to experience hyperacidity problems. The problem grew worse prompting me to stay away from such things as tomato products, spicy foods, alcohol, certain lentils, and caffeine (I had to give up tea, something I loved)" for more than a decade.

4. Serum Sugar and HbA1C Levels. In the latter part of 2004, a pathology laboratory I was using, reported my serum sugar level had increased to higher than the upper limit of normal. The HbA1C Enzyme level (an indicator of ninety-day performance) was at 5.8 mg/dl, 6 mg/dl being the upper limit of that range.

5. Snoring. According to my wife, my snoring had increased in the last fifteen years.

It is desired to assess if Pranayam will help alleviate these problems.

Having articulated the problem statement and declared the program goals, the next step is to prepare a process map showing the various steps and how they are linked. A process map of Swami Ramdev's Pranayam program is shown in Figure 3. Since Pranayam is seen to be an activity consisting of a series of steps, it is a work pro-

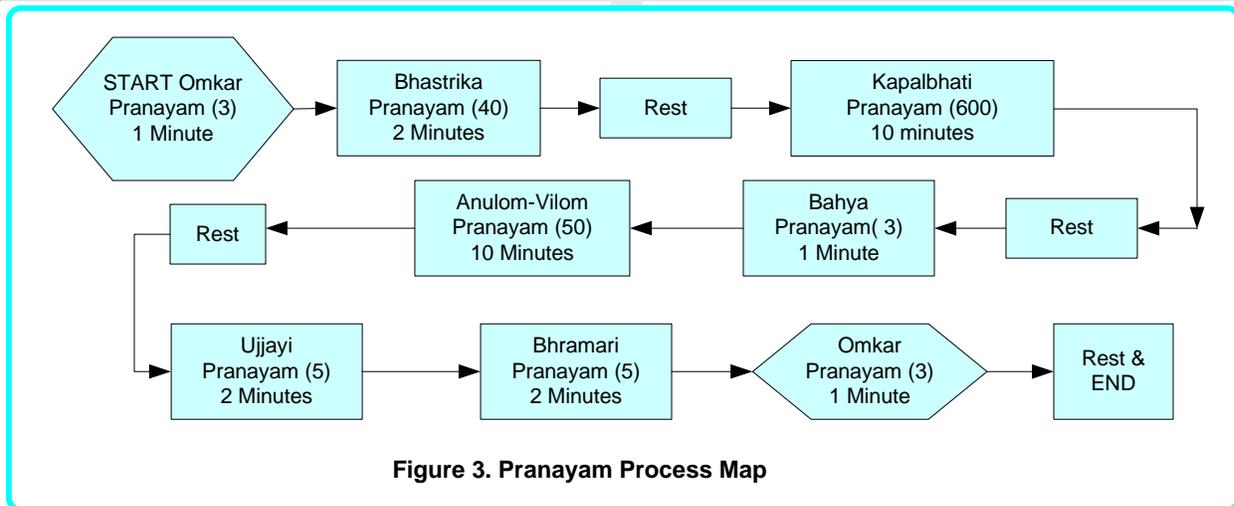


Figure 3. Pranayam Process Map

cess and so six sigma principles may be used to assess and improve its performance. The outcome of this work process are the health parameters whose performance is sought to be improved with Pranayam.

Six sigma principles require that measurements are repeatable and reproducible. This means laboratory technicians must be properly trained and instruments calibrated. Quantitative measurement systems are validated by taking two measurements of samples and insuring consistent results are obtained. For qualitative measurements, a subject must report consistent values of the parameters.

The next step is to collect data on the response variables and establish the baseline (synonymous with starting defect levels).

The following are the starting values of the qualitative parameters for the author:

1 Nasal allergies, chronic sinusitis	5
2 Hyperacidity	5
3 Constipation	5
4 Snoring	4

Scale for Attribute Data

1 = Problem nonexistent

5 = Problem chronic or severe

The starting values of quantitative parameters are listed in Table I.

Table I. Starting Continuous Response Variables

Date:	08-08-2004
Fasting Sugar, mg/dl:	121
HbA1C, %	5.7

The major impact factors influencing the health parameters were shown in Figure 1. The author has tried his best to insure that the parameters under his control remained as constant as possible. The parameters associated with the Pranayam exercises that can be optimized

are (1) the technique, (2) duration, and (3) number count of each Pranayam exercise.

It has been pointed earlier, human beings all have a unique common cause variability arising from heredity factors and how they have evolved to the present age. Furthermore, they are multivariable, nonlinear, and self regulating. As a result, the optimal values of these parameters may vary from one individual to the next.

We may well undertake a study later to find the optimal values and how different they are from one individual to the next but here we will be content to follow Swami Ramdev's recommendations for the durations and count listed in Figure 3. The rationale for using Swami Ramdev's recommendations is he appears to have done exhaustive investigations for several decades involving hundreds of thousands of subjects to arrive at the recommended values listed.

At the time of writing, the author has practiced Pranayam for a year and ten months. The following is a listing of the qualitative parameters as of June 2006.

1 Nasal allergies, chronic sinusitis	2
2 Hyperacidity	1.5
3 Constipation	2
4 Snoring	2.5

The quantitative values of the parameters after eighteen months of Pranayam are listed in table II.

Table I. Ending Continuous Response Variables

Date:	02-26-2006
Fasting Sugar, mg/dl:	96
HbA1C, %	5.2

"In an attempt to rule out the possible effect of medicines on skin rashes, I stopped taking antihistamines and decongestants on March 8, 2006 right in the middle of the allergy high season in Louisville. I have not taken ill

on account of these problems so far. Not only that, several times between March 8 and June 6, 2006 I felt like I was coming down with a sore throat and a cold, but was able to ward it off in a day or so, leading me to believe my immune system may have improved. Similar episodes had led to illness in the past requiring a visit to the doctor's office, antibiotics and breathing treatments, etc. In addition, my posture has improved and I seem to be able to recover from stressful situations quicker. I am pretty much able to eat and drink things I like without having to worry about hyperacidity and constipation although I hasten to add, Pranayam may not be a license for misbehaving."

"These results are so remarkable I am absolutely hooked to Pranayam and wish I had started twenty years earlier."

The last step of six sigma methodology is to monitor variables to insure problems once fixed stay fixed and progress is sustained. In this example, data frequency is low (once every six months) and so we will be content with checking every data point. We must also frequently check with the VCD to see if we are doing the exercises correctly.

Case Study II. Louisville Pranayam Group

A group of nineteen Louisville area residents volunteered for the study in the Fall of 2005. Participants are profiled on p.8. The group includes medical doctors, professors, senior engineering personnel, etc. The size of the group practicing Pranayam in Louisville has since doubled. The author provided each participant with a VCD on Pranayam marketed by Divya Yoga Trust and trained them in the exercises. They were also given an overview of six sigma. They then practiced Pranayam for three months to assess the health benefits.

The selected quantitative health parameters were measured in a pathology laboratory, courtesy of Dr. Rajan Amin, MD in Louisville. Each measurement was made twice to ascertain repeatability and reproducibility. Participants were asked to rate qualitative parameters on a scale of 1 (problem nonexistent) to 5 (problem acute or chronic).

The results of the Louisville study are summarized starting on Page 8. Each participant has provided a short paragraph on his or her experience with Pranayam. In the narrative, participants have focused only on those qualitative variables that are pertinent to them.

Eighteen out of nineteen participants report one or more of these benefits: a sense of calm, higher energy levels, and increased stamina. Even the nineteenth participant, who didn't feel any difference, says he is hooked to these exercises and does them regularly. Participants who had issues with sleep, control over bowel movement,

constipation, hyperacidity, and snoring report substantial improvement. Cholesterol and fasting sugar levels of a couple of participants have come down from higher than the upper limit of normal to lower than the same limit. Cholesterol and fasting sugar level benefit for participants whose values were not far away from the normal range appears to be minimal. Generally, laboratory results indicate not all individuals have benefited to the same extent. This is to be expected given the nonlinear nature of human systems; some benefits may accrue early in the program while some may take longer. Very significant benefits may be accruing but the evidence may come only after some time via several cause-and-effect blocks (for example involving the cardio reactive protein as pointed out by Dr. Sabharwal, an endocrinologist in the group).

Discussion.

To derive full benefits, Pranayam exercises need to be done correctly and diligently. Any flaws could lead to suboptimal results. The sample selected for this study is neither random nor it is large. Nonlinear systems require very large sample sizes before the conclusions of a study can be authoritatively extended to a wider population. Because blood work is involved in some measurements, estimates of the day-to-day variability in these parameters provided by the physicians in the group have been used. As with other forms of exercises, it would be prudent to seek the doctor's permission before undertaking these exercises.

To Conclude...

The remarkable benefits derived by the author, the experience of the Louisville Pranayam group, the reported benefits of the two other components of Yoga path, Asanas and meditation, at the MD Anderson Cancer Center in Houston, the genius of Patanjali, and the wisdom of Swami Ramdev who figured out the intricacies of how these exercises are to be performed, are all supportive of the claim, practice of Pranayam improves health. The benefits of Pranayam for the author are so significant, he dare not skip the exercises even for a day. However, who will derive which benefits and to what extent is unfortunately not predictable given the nonlinear nature of human systems with each having their own unique natural variability and how they have evolved from birth to the current age. That said, judging by the mechanics of how these exercises are done gives reason for hope a lot of ailments might be curable with Pranayam.

My saving in co-pay is a modest \$100 per month. However, my colleague at University of Louisville, Mark Schreck (formerly General manager/VP, GE Appliance Park at Louisville) estimates that a mere 5% reduction in healthcare costs at a company like GE represents \$194

million per year in savings and this doesn't include all the good things that would come GE's way because employees are feeling better, are able to better cope with stress, and so on. For all these reasons, the author believes Pranayam can significantly bring down national healthcare costs if diligently pursued.

Acknowledgments

The laboratory measurements for the majority of participants were made in the pathology laboratory of Dr. Rajan Amin by J. Scot Anderson, MLT and Gail Jones, MA. The manuscript was designed by Dr. Roberto Z. Tantalean.

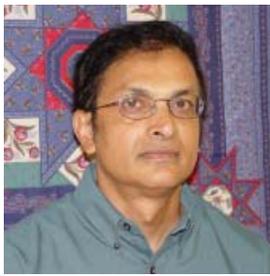
Further Reading

1. Bylinsky, G., "**How to Bring Out Better Products Faster**", *Fortune*, p. 238B (Nov. 23, 1998).
2. Capell, K., Arndt, M., and Carey J., **Drugs Get Smart**, *BusinessWeek*, September 5, 2005. p. 76.
3. Carley, W. M., "**Charging Ahead**", *Wall St. Journal*, p. A1 (Jan. 13, 1997).
4. Conlin, M., **Meditation**, *BusinessWeek*, August 30, 2004.
5. Deshpande, P. B., "**Six Sigma Enlightenment**", *BusinessWorld*, October 4, 2004.
6. Deshpande, P. B., Makker, S. L., and Goldstein, M., "**Boost Competitiveness via Six Sigma**", *Chem. Eng. Progress*, 95 (9), (Sept. 1999). p. 65.
7. Deshpande, P. B., "**Emerging Technologies and Six Sigma**", *Hydroc. Proces.*, p. 55 (April 1998).
8. Deutsch, C. H., "**Six Sigma Enlightenment**", *N. Y. Times*, p. C1 (Dec. 7, 1998).
9. Franklin, S., "**In Pursuit of Perfection**", *Chicago Tribune*, p. 5-1 (Apr. 4, 1999).
10. Harry, M. J. and J. R. Lawson, "**Six Sigma Productivity Analysis and Process Characterization**", Addison-Wesley, Reading, MA (1992).
11. Iyengar, B. K. S., **Light on Pranayama**, Harper Collins Publishers, India 2005.
12. Jones, D., "**Firms Aim for Six Sigma Efficiency**", *USA Today*, p. B1 (July 21, 1998).
13. Kumar, Hari, **India's Harried Elite Now Turns, and Twists, to Yoga Lite**, *New York Times*, Feb 1 2005. 15.
14. **On Vaccines and Calming Poses**, *Business Week*, June 19, 2006. p. 67.
15. Paul-Labrador, Maura et al., **Effects of a Randomized Controlled Trial of Transcendental Meditation on Components of the Metabolic Syndrome in Subjects With Coronary Heart Disease**, *Archives of Internal Medicine*, Vol. 166, No. 11, June 12, 2006 pp. 1218-1224.
16. Stein, J., **Just Say Om**, *Time*, August 4, 2003. p. 48.
17. **The New Science of Mind and Body**, *Newsweek*, September 27, 2004. p. 43.
18. **Yoga Helps Breast Cancer Patients**, *New York Times*, June 5, 2006.

Biographical Sketch of Author

Pradeep Deshpande is Professor Emeritus of Chemical Engineering, University of Louisville, Visiting Professor of Management, Gatton College of Business and Economics, University of Kentucky, and President and CEO of Louisville-based Six Sigma and Advanced Controls, Inc. During his 30 years at U of L, Pradeep supervised 20 doctoral and 40 master's students and has 100 publications & presentations, and 6 textbooks to his credit. He has made pioneering contributions to six sigma by deciphering what makes six sigma possible in the fundamental sense based on natural laws and has extended its applicability to dynamic systems. Pradeep was probably the first to introduce six sigma in a college curriculum in the U. S. and India. Partnering with a prestigious B School in Pune, India, Prof. Deshpande recently established **SCMHRD-SAC, USA Six Sigma Excellence Award** for corporate India, the first of its kind in the world.

In Their Own Words...



Suraj Alexander
 Ph.D. Industrial Engineering
 Virginia Polytechnic Institute
 B. Tech. Mechanical Engineering
 IIT Madras, India

	Parameters	Change	Units
Quantitative	Weight	1.5	Lbs
	Waist Size	2.5	Inches
	Cholesterol	20	mg/dl
	Sugar Level	-9	mg/dl
	Blood Pressure	0/2	mm Hg/ mmHg
	Pulse Rate	9	Beats/sec

Suraj is Professor and a former Chair of the Department of Industrial Engineering at the University of Louisville.

“Immediately after starting Pranayam my sleeping pattern has improved and I feel more calm.”

	Parameters	Change	Units
Quantitative	Weight		Lbs
	Waist Size		Inches
	Cholesterol		mg/dl
	Sugar Level		mg/dl
	Blood Pressure		mm Hg/ mmHg
	Pulse Rate		Beats/sec

Family Practice (1980 - 2005). Hospital Affiliation: Jewish Hosp., Norton Hosp., Audobon Hosp.

“I was pleased to provide laboratory resources for the measurement of quantitative parameters. In the light of the results of the study I hope to begin doing these exercises soon.”



Rajan Amin
 Family Practice, University of Louisville
 Pediatrics, University of Louisville
 MBBS, Seth G.S Medical College,
 Mumbai, India.

	Parameters	Change	Units
Quantitative	Weight	-3.5	Lbs
	Waist Size	0	Inches
	Cholesterol	-34	mg/dl
	Sugar Level	0.5	mg/dl
	Blood Pressure	6/10	mm Hg/ mmHg
	Pulse Rate	-29	Beats/sec

Jayant is Project Manager at the National Surface Treatment Center and works on US Navy’s Coatings and Corrosions Problems.

“Two things have improved noticeably due to Pranayam practice: quality of sleep and energy level. Snoring has also been reduced.”



Jayant Angal
 Ph.D. Chemical Engineering
 University of Utah
 B.Tech. Chemical Engineering
 IIT, Bombay, India

In Their Own Words...



Anju Datta
B.A. Hindi Literature
Meerut University, India

	Parameters	Change	Units
Quantitative	Weight		Lbs
	Waist Size		Inches
	Cholesterol		mg/dl
	Sugar Level		mg/dl
	Blood Pressure		mm Hg/ mmHg
	Pulse Rate		Beats/sec

Working in a Montessori School for the past 20 years.

“I had to take medicines for sinus problems most days. After doing Pranayam, I don’t seem to need sinus medicines. Feels good after doing Pranayam.”

	Parameters	Change	Units
Quantitative	Weight		Lbs
	Waist Size		Inches
	Cholesterol		mg/dl
	Sugar Level		mg/dl
	Blood Pressure		mm Hg/ mmHg
	Pulse Rate		Beats/sec

Subodh is President and CEO of SECAT, Inc. in Lexington, Kentucky.

“Since starting Pranayam, there is much less anxiety and I am calmer. Also, I monitor my blood pressure every day and it is down by 10 points (both readings) on average.”



Subodh Das
 Ph.D. Metallurgical Engineering
 University of Michigan
 B. S. Metallurgical Engr., BIT, Sindri.
 M. S. Metallurgical Engr. IIT Kanpur



Vijay Datta
 M.S. Chemical Engineering
 New Jersey Institute of Technology
 B.Tech. Chemical Engineering
 IIT, Delhi, India

	Parameters	Change	Units
Quantitative	Weight		Lbs
	Waist Size		Inches
	Cholesterol		mg/dl
	Sugar Level		mg/dl
	Blood Pressure		mm Hg/ mmHg
	Pulse Rate		Beats/sec

Vijay has been at ICI Paint since 1971 and is currently Director of R&D in the Technical Department.

“A great relief with constipation, believe it or not it was relieved 100% ([5] to [1]). I also became very calm, relaxed, and felt full of energy. Some of these benefits could be due to change of duties at the office though.”

In Their Own Words...

	Parameters	Change	Units
Quantitative	Weight	+1	Lbs
	Waist Size	-1	Inches
	Cholesterol	-11	mg/dl
	Sugar Level	+3.5	mg/dl
	Blood Pressure	0/2	mm Hg/
	Pulse Rate	-12	mmHg Beats/sec

Roberto is a Consultant for Six Sigma and Advanced Controls, Inc. in Louisville, Kentucky.

“I started noticing that my sleeping quality significantly improved after the third or fourth day I started performing Pranayam. This, along with my higher energy level, has encouraged me to continue on Pranayam.”



Roberto Tantalean

Ph.D. Chemical Engineering
University of Louisville
M.S. Computers Science
University of Cantabria, Spain
B.S. Chemical Engineering
University of Trujillo, Peru



Ved Gakhar

MBA University of Louisville
M.S. Mechanical Engineering
University of Minnesota
B.S. Mechanical Engineering
University of Agra, India.

	Parameters	Change	Units
Quantitative	Weight	-1	Lbs
	Waist Size	-2	Inches
	Cholesterol	42.5	mg/dl
	Sugar Level	10.5	mg/dl
	Blood Pressure	2/16	mm Hg/
	Pulse Rate	6	mmHg Beats/sec

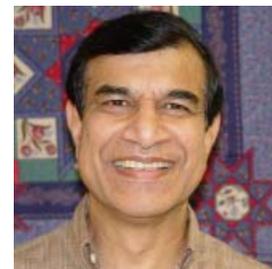
Ved was Manager, Innovations & Advanced Development, Robert Bosh Tool Corporation, Mount Prospect Illinois at the time of his retirement in 2004.

“I can’t pinpoint any specific positive change in my well being but something about these exercises has me hooked .”

	Parameters	Change	Units
Quantitative	Weight	-9	Lbs
	Waist Size	-1	Inches
	Cholesterol	-30	mg/dl
	Sugar Level	+30	mg/dl
	Blood Pressure	-16/-19	mm Hg/
	Pulse Rate	-2	mmHg Beats/sec

Zafar is Professor and Director of Maxillofacial/Oncologic Dentistry, J.G. Brown Cancer Center, University of Louisville.

“My constipation problem has nearly disappeared ([5] to [1]). Since doing the exercises I feel more energetic, also mentally comforting, overall.” The increase in sugar is probably due to the candy I consumed late at night before the test.



Zafrulla Khan

FACP SUNY, Buffalo, NY
MD Anderson Cancer Center
M. S. University of Louisville
DDS Bangalore University

In Their Own Words...

Quantitative	Parameters	Change	Units
	Weight	2	Lbs
	Waist Size	1	Inches
	Cholesterol	-23.5	mg/dl
	Sugar Level	-23	mg/dl
	Blood Pressure	-4/5	mm Hg/mmHg
	Pulse Rate	4.5	Beats/sec

Working as Sales Engineer for Graham Hydraulic for the last 22 years.

“After doing Pranayam, I feel very energetic. I feel slimmer and my stomach has been reduced. My snoring has reduced quit a bit.”



Ravi Jain

M.S. Industrial Engineering
Stevens Institute of Tech., USA
B.S. Mechanical Engineering
Vikram University, India



Renu Lonial

MAT University of Louisville
B.Sc. Delhi University

Quantitative	Parameters	Change	Units
	Weight	0.5	Lbs
	Waist Size	-	Inches
	Cholesterol	-80	mg/dl
	Sugar Level	-6	mg/dl
	Blood Pressure	-35/-10	mm Hg/mmHg
	Pulse Rate	0	Beats/sec

Renu served as Director of Dietetics in a Hospital and is a Nutritionist in private practice for twenty five years.

“My acidity, constipation, and allergies have improved from [4] to [2]. In the beginning I felt more energetic and generally felt better. Later my migraine came back with a vengeance that prevented me from being regular. I Would recommend it highly.” The cholesterol benefit may be partly due to the Statin drug I started during the program.

Quantitative	Parameters	Change	Units
	Weight	0	Lbs
	Waist Size	0	Inches
	Cholesterol	1	mg/dl
	Sugar Level	-12	mg/dl
	Blood Pressure	-2/-9	mm Hg/mmHg
	Pulse Rate	-8	Beats/sec

Pushpa retired from a position at a Bank in Louisville some years ago.

“I feel my waist has reduced by about an inch and I feel energized. I am sleeping much better after I started these exercises. Feels really great.”



Pushpa Makker

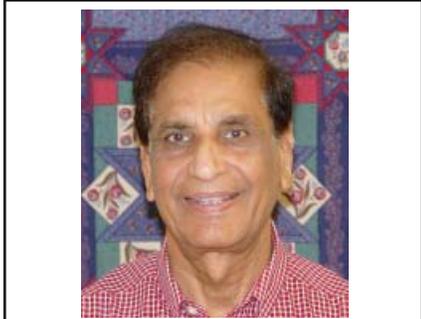
B. A. Miranda College,
Delhi University, India

In Their Own Words...

Quantitative	Parameters	Change	Units
	Weight	-1	Lbs
	Waist Size	0	Inches
	Cholesterol	-3.5	mg/dl
	Sugar Level	-14	mg/dl
	Blood Pressure	12/0	mm Hg/ mmHg
	Pulse Rate	-8	Beats/sec

Sohan is a Six Sigma Consultant. He was Manager, Pricing and a Certified Six Sigma Black Belt at the General Electric Company in Louisville prior to retirement a few years ago.

“I feel my waistline has reduced by about an inch. Always feel good not only right after the exercises, but the whole day. Freedom from colds. Feel great.”



Sohan Makker

MBA University of Dallas
M.S. Industrial Engineering
University of Arkansas
B.Sc. Mechanical Engineering
Aligarh Muslim University, India



Babu Nahata
Ph.D. Economics
Northern Illinois University
M.S. Polytechnic Institute of New York
M.S. IIT, Chicago
B.S. Birla Institute of technology, India

Quantitative	Parameters	Change	Units
	Weight	-1.5	Lbs
	Waist Size	-2.375	Inches
	Cholesterol	21	mg/dl
	Sugar Level	0.5	mg/dl
	Blood Pressure	-2/2	mm Hg/ mmHg
	Pulse Rate	0	Beats/sec

Babu has been on the faculty at the University of Louisville for twenty seven years and is currently Professor of Economics and Co-Director, Center for Emerging Markets in the College of Business and Public Administration.

“High level of energy. Overall good healthy feeling.”

Quantitative	Parameters	Change	Units
	Weight		Lbs
	Waist Size		Inches
	Cholesterol		mg/dl
	Sugar Level		mg/dl
	Blood Pressure		mm Hg/ mmHg
	Pulse Rate		Beats/sec

Sahro Nawab makes a home in Louisville, Kentucky. Sahro has taught yoga in Louisville for eight years.

“I really feel energetic, my appetite has gone down and I feel I am able to recover from stressful situations much more quickly.



Sahro Nawab
B. S. History, Loreto College,
Lucknow, India

In Their Own Words...

	Parameters	Change	Units
Quantitative	Weight	-5	Lbs
	Waist Size	-1.5	Inches
	Cholesterol	+15	mg/dl
	Sugar Level	+4	mg/dl
	Blood Pressure	-6/-8	mm Hg/ mmHg
	Pulse Rate	-6	Beats/sec

Vinod is currently President of Cymbion LLC which produces infection control products for use in hospitals. He has been in the US since 1989.

“Feeling energetic, snoring is appreciably reduced, feel rested, energy level is good, and have lost about 5 pounds. There is no more dyspepsia (heartburn and eructation).”



Vinod Narula
 MBA Marshall University
 Huntington, West Virginia
 Master of Surgery
 Poona University, India
 MBBS Punjab University, India



Kailash Sabharwal
 Board of Endocrinology
 Board of Internal Medicine
 MBBS, MD
 All India Institute of Medical
 Sciences, Delhi, India

	Parameters	Change	Units
Quantitative	Weight	-1	Lbs
	Waist Size	-0.5	Inches
	Cholesterol	+9	mg/dl
	Sugar Level	+10	mg/dl
	Blood Pressure	0	mm Hg/ mmHg
	Pulse Rate	0	Beats/sec

Practicing Endocrinology and Internal Medicine since 1973.

I have thoroughly enjoyed these Pranayam exercises. I feel I have more energy and my breathing capacity has improved. I have an improved control over bowel movement and have lost half an inch in my waist size with no significant change in body weight. CRP has improved to a lower level.

Being an endocrinologist and seeing type II diabetics and metabolic syndrome with central obesity, I feel these breathing exercises will reduce the amount of intra-abdominal fat. We realize that abdominal fat is the worst form of fat because it is metabolically active and produces cytokines.

This could mean less development of diabetes and improvement in cardiovascular risk. I am beginning to teach some of these exercises to my own patients.

The best part of these exercises is that (a) they can be done at home without having to join a health club, (b) some of them can be done even while driving to work, and (c) they can be prescribed for people with arthritis of arms, legs, and back pain.

I am truly grateful I learned these exercises and have obtained these benefits. Many others can also get these great benefits with this format.

In Their Own Words...

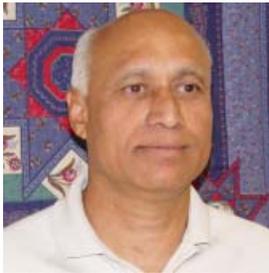
	Parameters	Change	Units
Quantitative	Weight	-3.5	Lbs
	Waist Size	0	Inches
	Cholesterol	0	mg/dl
	Sugar Level	-14	mg/dl
	Blood Pressure	1/-2	mm Hg/
	Pulse Rate	-11	mmHg Beats/sec

Anupama is a professional singer and a former radio announcer.

“I feel my stamina has improved and my allergies have reduced. I have lost a few pounds and my clothes fit better.”



Anupama Sahasrabudhe
M. A. (Vocal Music) Nagpur University, India.



Ravi Sahasrabudhe

MBA University of Louisville
M. Tech. Mechanical Engineering
IIT Bombay
B. Tech. Mechanical Engineering
Bhopal Engineering College, India.

	Parameters	Change	Units
Quantitative	Weight	-4.5	Lbs
	Waist Size	-2.125	Inches
	Cholesterol	-12.5	mg/dl
	Sugar Level		mg/dl
	Blood Pressure	-6/-5	mm Hg/
	Pulse Rate	-5	mmHg Beats/sec

Ravi is a Senior Engineer and a Six Sigma Green Belt at the General Electric Company in Louisville.

“I have been doing yoga for over 15 years and am in good health. After starting Pranayam, I feel fresh. I enjoy Kapalbhathi, Bahya, and Ujayyi Pranayams. My snoring has reduced considerably and also the effect of aerophagy has reduced”.

Appendix I. Six Sigma Overview

Six sigma has been defined as a strategy that identifies and eliminates causes of defects in work processes by focusing on their outcomes that are critical to customers. Six sigma also denotes a specific performance level. A six sigma process or transaction produces extremely few defects - 3.45 defects per million opportunities (99.99965% defect-free), for a process with a single sided specification. Six sigma is a journey and not a destination. Significant financial benefits from six sigma begin to accrue soon after implementation although it could take many years to reach six sigma defect levels.

Six sigma was pioneered at Motorola during the late seventies/early eighties. The popularity of six sigma is due to its tremendous success at General Electric Corp. A large number of Companies in the United States have corporate-wide six sigma programs in place.

■ *What is a defect?*

A defect is something, or anything, that leads to customer dissatisfaction. A customer can be internal or external to an organization, or be an end-user. Here are some example processes that are 99% good (i.e., 1% defective):

- A Mail processor is losing 20,000 articles per hour.
- A service provider is receiving 5,000 angry customer calls per week.
- At a large IT Center, there is no computer access for 2 hours per week.
- Drinking water is unsafe for 15 minutes each day.

Six sigma is *the* approach to reducing defect levels in all processes, manufacturing and transactional. When six sigma is implemented, defect levels plummet, customer satisfaction skyrockets, bottom-line improves, and globally competitive positions materialize.

If the example processes cited above were improved so they were at six sigma the performance improvement would be dramatic:

- The Mail processor would lose just 7 articles per hour.
- A service provider will receive 2 angry customer calls per week.
- There would be no computer access for 1 hour in 34 years.
- Drinking water would be unsafe for 1 minute in 7 months.

■ *Work process*

A work process is an activity that consists of a series of steps. Viewed this way, nearly all human activities are work processes.

■ *Significance of Improving Performance of Work Processes*

Every work process has an outcome by which its performance is measured. In six sigma jargon, the

outcome of a work process is referred to as effect, output, or response variable. Response variables (outcomes of work processes) have specifications imposed on them by the customers they serve. An example of a single-sided specification is “A train is to arrive at a station no more than 10 minutes late” and an example of a double-sided specification is “viscosity of a polymer produced in a batch reactor must be between 550 and 600 centipoise”. Out-of-spec response variables lead to defects as perceived by internal or external customers. Minimizing defect levels is synonymous with achieving highest levels of customer satisfaction. Maximizing customer satisfaction leads to higher market share, improved bottom-line performance, and globally competitive positions.

As to the significance of reducing defects, let us take the train arrival time as an example. Suppose we have taken arrival time data on 50 random days and have computed its average and the standard deviation (standard deviation denotes typically how far are data points away from the average and it may be computed by a formula). Reducing defects via six sigma means moving the average in a favorable direction (in this case, reducing it so it is closer to the target arrival time) and reducing the standard deviation. If we can bring this about, defects will go down and the benefits of six sigma will accrue. Generally speaking, six sigma programs aim at achieving one or more of these objectives; improve quality, reduce cycle time, and reduce costs. Realization of these objectives is made possible by the three fundamental laws of nature cited in the article that are the foundation of six sigma.

■ *Six Sigma Implementation*

Armed with the three natural laws, it is possible to write down a step-wise procedure for implementing six sigma.

■ First, we **Articulate the Problem Statement** that is giving rise to customer dissatisfaction (e.g., 35% of train arrivals are more than 10 minutes late). Then, we define the outcome of this work process (e.g., **Arrival Time, Minutes**) and identify the desired outcome (e.g., **Reduce Late Arrivals, let us say, by 50%**). The extent of improvement specified is speculative at this time because we do not know the extent of natural variability present in this process, and furthermore even if the specified objective were achieved, it will not take the process to six sigma levels (3.45 late arrivals in 1 million arrivals) Nonetheless, the benefits of specified defect reduction will be substantial.

■ The next step is to **Draw a Process Map** showing all the steps in the process including linkages between steps. The process map in the case of the Train Arrival Process should include all the steps from the time the train leaves the origination station til it arrives at the destination station.

The *karma* concept states the outcome of this process, Arrival Time, is impacted by causes. It does not tell us what the causes are. We wish to determine what the causes are via six sigma so we may work on them to improve the outcome performance. There is customer dissatisfaction because there is excessive variability in this outcome, that is, the average is not where it should be and the standard deviation is too large. Some of this variability is due to common causes which we cannot do anything about, within the scope of the problem being scrutinized, but a lot of the variability is quite possibly due to causes that we can do something about (special causes). Every one of the steps on the Process Map is a potential contributor to the variability of the outcome. In a future step, we shall determine which of these potential causes are in fact responsible for introducing variability in the outcome.

■ The next step is to **Validate Measurement Systems**. The central idea is the variability in the outcome must come from causes not from errors in the measurement systems. Take a Voting Process involving voters coming into a polling booth for voting in an election as an example. Here, voters fill out a ballot paper which is then processed by a vote counting machine which interprets the results. Clearly, we would want the variability in the outcome (Interpreted Results) to come from causes (Voter Intent) and not from errors in measurement systems (confusing ballot paper design, error-prone vote counting machine). In fact, such errors must be a very small fraction of the margin of victory between the top two candidates or else the election results would be suspect. It is extremely important to validate measurement systems before proceeding to the next step in the six sigma implementation strategy.

■ The next step is to **Collect Data on the Outcome** (response variable) and **Establish the Current Defect Levels**. It is important to establish the baseline (current performance) so improvement from six sigma can be properly catalogued. Then, **Properly Designed Procedures** are employed to collect data on potential causes and response variable(s). Remember potential causes are every one of the steps on the process map.

Analysis of the data collected will allow for the **Identification of Causes** (called Major Impact Factors) responsible for introducing variability in the outcome. The **Major Impact Factors** so determined are **either set at the optimal values or we work on them and eliminate them as appropriate**. When this is done, the average of the response variable moves in a favorable direction and the standard deviation reduces and all the benefits of six sigma accrue.

■ The last step is to put in place a plan to **Monitor Response Variable(s)** and factors so benefits of six sigma are sustained and problems once fixed stay fixed.

■ *Who Needs Six Sigma?*

I was interviewed on BBC Radio soon after Prince Charles paid a visit to Mumbai in November 2004 to personally witness the Dabbawallas' operations having learned these lunch box delivery boys delivered a level of performance that was on par with Motorola's and that according to Forbes earned them a six sigma rating. Some have asked if these folks, mostly uneducated, could achieve six sigma performance levels, then, where is the need to adopt six sigma? To help answer this question, it may be worthwhile to recall the ancient verse from RigVed, "Reality is one, the wise call it by many names". The likes of Dabbawallas, Toyota Motor Company, and perhaps a few others who are providing products and services with few defects, are necessarily following six sigma principles, whether or not they call it that, or for that matter, whether they even realize it or not. Whether to adopt six sigma in a formal way should depend on what the defect levels are. If they are high, and they will be for the vast majority of organizations in all sectors who have not adopted six sigma, then it behooves them to embrace six sigma. Successful six sigma implementation will result in high levels of customer satisfaction leading to better bottom-line performance and globally competitive positions.