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Quality Management and Juran's Legacy

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ABSTRACT Quality management provides the framework for the industrial application of statistical quality control, design of experiments, quality improvement, and reliability methods. It is therefore helpful for quality engineers and statisticians to be familiar with basic quality management principles. In this article we discuss Dr. Joseph M. Juran's important contributions to modern quality management concepts, principles, and models. Many people have contributed to modern quality management. However, through his extensive writings covering more than six decades, Juran has managed to distill and synthesize the subject. He has provided us with a coherent framework and terminology and anticipated many of the principles that subsequently became incorporated under the Six Sigma umbrella. We briefly outline Juran's framework and discuss a number of key contributions he has made to the subject of managing for quality.

KEYWORDS Design for Six Sigma, quality engineering, Six Sigma

INTRODUCTION

Quality management provides the framework within which modern statistical quality control, quality improvement, and reliability operate. Only when imbedded within a managerial framework do statistical tools and techniques become fully operational and effective. Quality management provides the structure, policies, and organizational environment in which statisticians and quality professionals can get work done. However, quality engineers and statisticians are often primarily focused on tools and techniques. They are typically not well versed in the managerial aspects related to how quality activities are effectively organized and managed within an organization. Indeed, Six Sigma advocates seem at times preoccupied with statistical tools and road maps and pay less attention to the larger managerial framework.

Besides possessing the necessary technical skills, it is useful for quality professionals to supplement their knowledge base with a basic understanding of quality management principles. One of the most prolific contributors to modern quality management was Dr. Joseph M. Juran. In this article we review Juran's legacy. Many have obviously contributed to quality management. However, Juran, more than anyone else, unified the concepts and brought them together as a system. In our estimation, he was the quintessential synthesizer of the field. His concept of managing for quality, comprehensively outlined in his book *Juran on Leadership for Quality*,

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(Juran, 1989), is a generic system that we expect will have a long lasting universality. It has provided the blueprint for the subsequent Six Sigma movement. Indeed, some of Juran's ideas have yet to be adopted by Six Sigma for that approach to be a comprehensive quality management system.

The purpose of this article is twofold: (a) to describe Juran's comprehensive quality management framework and (b) to highlight some of Juran's most important contributions to modern quality management. In doing so, we hope to assist quality professionals primarily familiar with statistical tools and techniques, to gain a better understanding of Juran's management framework as well as developing an interest in studying Juran's many books and publications.

A BRIEF HISTORICAL BACKGROUND

Quality management as we know it today has evolved over the past century from an early embryonic set of ideas to a comprehensive framework for managing all aspects of quality in an organization, private or public, for profit or not, manufacturing or service. Early contributions began before World War I. For example, the textile business that played a pivotal role in the industrial revolution was an early proving ground for many quality related ideas. However, if we seek a formal birth date, it seems fair to assert that the publication of Dr. Walter Shewhart's seminal 1931 book, *The Economic Control of Quality of Manufactured Product*, heralded the beginning of modern statistically based quality management.

During the 1920s it was recognized that statistical principles were needed to guide the development and evaluation of sample inspection procedures. Further, it was recognized that random variation needed to be accounted for in the monitoring and control of production processes. Much of the early statistical work took place within the Bell Telephone Company. For example, Shewhart is credited for having invented the control chart in 1924 and H. F. Dodge and H. G. Romig developed early acceptance sampling theory. They all worked for Bell Labs; see Millman (1984). Further, after graduating as an electrical engineer, in 1924 Joseph M. Juran assumed a position in the inspection department of Western Electric Company, the production division of the Bell System, responsible for producing communications hardware; see Juran (2004).

Although Shewhart primarily focused on statistical issues relevant to quality control, he also discussed managerial issues. However, most of his managerial emphasis was on organizing and managing the inspection function. Juran's first book, *Management, of Inspection and Quality Control* (Juran, 1945), published in 1945, right after he left Western Electric to venture into consulting and teaching, had a similar focus.

Quality management in the modern sense was not discussed in the literature until after World War II. Even then, the field only evolved slowly over the following decades. In the early 1950s both Dr. W. E. Deming and Dr. J. M. Juran were invited to consult for the Japanese industry about the implementation of quality control. Both based their advice to Japanese executives on their experience before and during WWII in United States implementing industrial quality control. Both had been frustrated about the ineffectiveness of quality control when (a) upper management only exhibited a passing and superficial interest in managing the quality function and (b) systems were based primarily on inspection. Both came to the conclusion that to be effective, efforts should have strong top management leadership and should include activities aimed at finding and eliminating root causes for poor quality, not just passive inspection. Indeed, both came to the conviction during the 1950s that a comprehensive system for managing quality was critical. Deming's focus was primarily philosophical and strategic. His main contribution has been to educate upper management in the critical strategic role played by quality in a competitive economy. His writing is mostly focused on quality concepts, paradigms and philosophies. Deming's work is essentially setting the stage for initiating quality efforts in an organization and as such essential. However, his writing is not particularly specific in his advice about how quality should be implemented and organized in a company. Juran, on the other hand, while not silent on strategic issues was more hands-on, prescriptive, and developed comprehensive and detailed practical guidelines for the development and implementation of a quality management system. His ideas clearly evolved over the years, but the fundamental concepts were already evident in the first edition of his quality handbook (Juran, 1951). A side-by-side comparison of Deming's (1986) book *Out of the Crisis* with Juran's

(1989) *Juran on Leadership for Quality* brings out these differences. However, it should also be noted that these two scholars' works are complementary, not antithetical. It is not an issue about which book is better or whose theory is superior. Both Deming and Juran have made valuable contributions. Both were "giants" in the field. Each emphasized different issues. Indeed, there are few essential disagreements between them. Among statisticians Deming is better known, but Juran deserves equal recognition.

Deming's and Juran's teachings to Japanese executives, managers, and engineers were not one-way communications. Both seemed to have learned from their work in Japan. Both brought back many good ideas. Surely the Japanese applied the ideas they learned from their American teachers. But they also made significant contributions themselves. By applying what they learned, the Japanese saw what worked, what did not work, what shortcomings existing approaches had, and came up with whole new ideas of their own. Thus, many Japanese industrialists, engineers, and scholars such as K. Ishikawa, S. Toyoda, T. Ohno, S. Mizuno, H. Kume, N. Kano, and G. Taguchi have made valuable contributions to "the body of knowledge." For an overview of the history of modern quality management, see Garvin (1988, chapter 1) and Juran (1995).

JURAN'S CONTRIBUTIONS TO QUALITY MANAGEMENT

Although his 1945 book discussed management issues, Juran's serious entry into the field of quality management was the publication in 1951 of the first edition of the *Quality Control Handbook*. This seminal book, edited by Juran with numerous chapters written by him, propelled Juran to the forefront of the field and caught the attention of Japanese industrialists. Although there is a clear evolution and maturing of the field over the years, the combined content of the five editions of the *Juran Quality Handbook* (Juran, 1962; 1947; 1988b) issued roughly every 10 years since 1951 constitute an essential source for Juran's thinking about quality management and for the entire field. All five editions are significantly different. Each contains different materials. All are worthwhile reviewing. As indicated above, Juran did not write everything himself. However, he supposedly exercised strong editorial control and was very hands-on in the development of these monumental books. The general trend from the first to the fifth edition is a gradual change of focus from a technical to a managerial. His book *Managerial Breakthrough* (Juran, 1964) is also important. However, for a modern presentation of his evolving view of what he seemed to prefer to call "managing for quality" we recommend *Juran on Leadership for Quality* (Juran, 1989). Other important books are *Juran on Quality by Design* (Juran, 1992) and *Juran on Planning for Quality* (Juran, 1988a). His autobiography (Juran, 2004) is also interesting but primarily about his Horatio Alger–like personal life, struggles, and successes. His book with longtime partner Dr. Frank Gryna (Juran and Gryna, 1993) constitutes a solid university course textbook. Later, new or revised editions of books organized by the Juran Institute but published after Juran himself withdrew from daily involvement seemed to have compromised the clarity of Juran's vision. Some of this seemed to have been in an effort to keep up with the Six Sigma movement. However, to us it seems that Six Sigma only "borrowed" parts of Juran's trilogy, to be discussed below. Thus, we find that the best expression of Juran's mature views on quality management are to be found in Juran (1989) or Juran and Godfrey (1999).

Juran's main contribution to modern quality management was his concept of what is known as the *Juran Trilogy*. This is a conceptualization of managing for quality consisting of three main functions: *quality planning*, *quality control*, and *quality improvement*. To fully appreciate this concept, we first discuss Juran's work on defining quality, related economic models for quality, and his economic perspective on the societal importance of quality. We then discuss his management trilogy. We also review his insight to how to implement quality improvement at the top management level. Finally, we discuss Juran's work on developing precise definitions, terminology and concepts, something fundamental to any field of study.

Juran's Definitions of Quality

Without well-defined terminology, discussions about quality and quality management easily get confused. Juran recognized that the word "quality" is not easily defined. Dictionaries provide many definitions, most of which are too vague or philosophical

for technical use. However, Juran's definition of quality as *fitness for use* is widely recognized today as one of the more useful. To appreciate the subtleties of this seemingly awkward definition, consider the following example. If a busy business traveler needs a simple, clean, and safe accommodation for the night, an expensive five-star hotel room may not constitute "fitness for use" despite its luxury delivered to perfection. However, the same person may come back the next week for a vacation with the family and find the same hotel a perfect "fit" for that use and therefore now be delighted with the quality. In other words, it is the customer, not the provider, who defines quality. Further, quality depends on the circumstances and it is not "more is better" but "fitness for use" that is the key issue. Quality is a bundle of attributes timely delivered to satisfaction that solves the customer's problem. In economic terms, quality is a non–price competitive market signal. Quality does not thrive in monopolistic circumstances. Rather, in a competitive economy, customers have choices. There are typically multiple alternative market offerings, but ultimately customers will vote with their pocketbooks based on a trade-off between cost and quality. Quality is what appears appealing and fit to the customer relative to alternative market offerings.

Older definitions of quality such as "conformance to specifications" are no longer adequate at the highest conceptual level. Specifications may be useful surrogates at lower conceptual levels—intrafirm and operationally—but cannot serve as the predominant definition. Quality must be defined relative to the customer's needs and expectations.

Although "fitness for use" is the predominant definition, Juran realized a need for further subsidiary definitions, chiefly for economic reasons. On the one hand, some people may argue that high quality "obviously" will be more costly and expensive. Advocates of that viewpoint implicitly think of quality in terms of more *features*. On the other hand, others may argue that high quality is cheaper. This may seem contradictory but is not. Advocates of that viewpoint consider the cost of defects, delays, rework, and waste, or, more broadly, *deficiencies* associated with poor quality. They understand that first doing things incorrectly and then having to fix it inevitably is expensive. Reducing deficiencies therefore reduces costs. Permanently removing the causes of deficiencies is even better.

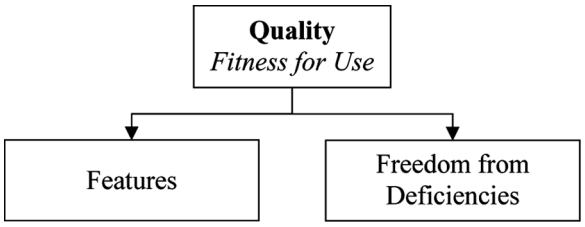

FIGURE 1 **Quality defined by Juran as "fitness for use" and his two subsidiary definitions as "features" and "deficiencies."**

Clearly both viewpoints have merit. Juran resolved the quandary by providing two subsidiary definitions to quality: (a) *features* and (b) *freedom from deficiencies* as illustrated in Figure 1. Features have to do with the design of the product, process, or service. It is what we intend to deliver. Deficiencies have to do with the actual delivery. This profound distinction is only slowly gaining popularity but is important, especially in the context of Design for Six Sigma. More importantly, the distinction is key to understanding the economic reasons for pursuing quality as a strategic objective, something Toyota Motor Company, for example, consistently has done with extraordinary success.

Admittedly, we have not been able to come up with a better definition to replace Juran's "fitness for use." However, Juran's "features" and "freedom from deficiencies" terminology may perhaps today seem somewhat obsolete. Although we will continue to use Juran's terminology in this article devoted to a discussion of his contributions, we find that "design quality" and "delivery quality" better capture the two subsidiary notions. Others may prefer to use "quality of design" and "quality of conformance." The word "design" connotes what is desired and something more general, strategic and important than "features." This term also seems better suited when applied relative to a general market offering whether a product or a service. Also, rather than "freedom from deficiencies" we find the word "delivery" more generally applicable to products and services and more appealing than the authoritarian-sounding word "conformance."

Juran's Economic Perspective

We are concerned about quality not necessarily because we aspire to win quality awards. The real reason is because striving for superior quality is

sound business economics. As Drucker (1973, p. 60) noted, "Profit is not the explanation, cause, or rationale of business behavior and business decisions, but the test of their validity." Milton Friedman has put it more bluntly: "The business of business is business." In today's competitive business environment, quality initiatives must justify themselves economically. Quality is important because it delivers competitive advantage and measurable, tangible economic benefits in terms of reduced costs, better customer satisfaction and improved bottom line profitability. The opening chapter of the first edition of Juran's *Quality Control Handbook* is entitled "The Economics of Quality." In other words, in 1951 Juran was already keen on the economic aspects of quality. Below we discuss a firm-specific as well as a more global societal perspective of the economics of quality.

Economic Model

Juran's definition of quality and the two subsidiary definitions as features and deficiencies provide the basis for understanding the business economics of quality. Typically, improving (design) quality in terms of features will increase the cost of producing a product or service. However, it will also allow the company to charge a higher price and may increase sales volume. In accounting parlance, added or improved features have a beneficial top-line effect. On the other hand, improving (delivery) quality by reducing the number of errors and deficiencies will usually dramatically reduce costs. Thus, it has a "middle line" cost-saving impact that immediately trickles down to the "bottom line" as increased profit. In the long run, reducing deficiencies will also improve a company's market reputation and its brand. Therefore, reduced deficiencies may allow for charging a premium price, increase the market share or both. Figure 2 provides a graphical summary of the economic relations. Given these simple economic relations, it can be seen that the common but naïve perception that "high quality costs more" is not necessarily true. In fact, when it comes to deficiencies the contrary is usually the case: *high quality costs less!* This is why top executives ought to be keenly interested in quality.

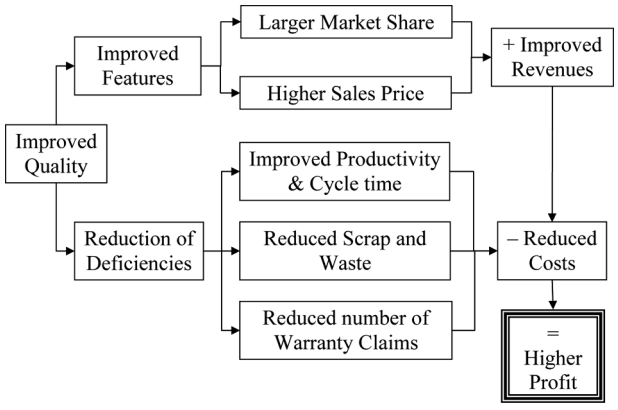

FIGURE 2 **A graphical summary of the economic relations of quality defined as features and deficiencies. Improving features primarily impact the "top line." Reducing deficiencies impacts the "middle lines." Both contribute to improving the "bottom line."**

Cost of Poor Quality

Juran is credited for having developed most of the fundamental concepts and theory behind what is call cost-of-poor-quality (COPQ). Feigenbaum (1961) and Crosby (1980) have also made important contributions in this conceptual area, but Juran's efforts were early, comprehensive, and have had lasting impact. Rather than the confusing notion of "cost of quality," used by many authors, Juran defined the concept of "cost of poor quality" (COPQ) as "the sum of all costs that would disappear if there were no quality problems." Cost-of-poor-quality concepts are accounting tools adapted to assess the economic consequences of poor quality; that is, deficiencies. Juran recognized that upper management primarily understands and deals with money-related issues. Thus, for communication reasons, he noted that it makes sense to try to communicate in monetary terms the impact of poor quality and use these concepts to justify quality programs, select projects and account for actual results. For more on this, see Campanella (1990) and Bisgaard and Freiesleben (2000).

Societal Impact of Quality

Juran has also addressed the larger societal perspective of the importance of quality. Several editions of Juran's *Quality Handbook* elaborate on these themes. However, we briefly mention that Juran pointed out that in an increasingly sophisticated industrialized society, quality in a general sense is imperative. We have all become dependent on reliable products, services, and systems. We have

concerns about protection against power outages, clean water, environmental catastrophes, safe drugs, safe products and services in general, safe medical care, reliable communication channels, healthy food, etc. As Juran explained, "like the Dutch who have reclaimed so much land from the sea, we secure the benefits of technology. However, we need protective dikes in the form of good quality to shield society against service interruptions and to guard against disasters." Juran calls this "life behind the quality dikes." Quality assurance is important from a societal perspective even if rarely yet discussed by economists.

A Unified Quality Management Framework: The Juran Trilogy

One of the key contributions by Juran is his unified concept of the Juran Trilogy, a comprehensive framework and set of principles for organizing quality within an organization. This concept was first articulated in Juran (1986). Based on his experience at the Hawthorne Works of the Western Electric Company, Juran rejected the notion early that quality was only an inspection function; see Juran (1993). He further objected to the notion that quality should be the sole responsibility of the quality inspection department. In his view, the responsibility should remain with the operating departments; those that make the defects have the responsibility for them, not the inspectors. Any other allocation of responsibility will have disastrous consequences for quality and operational costs. Moreover, he was keen on breaking down institutional barriers that prevented quality improvement initiatives. As he learned as a young engineer, in a traditional management environment, "production was the job of one unit, quality of another unit, and no one was in charge of process improvement"; see Juran (1993, p. 40).

Juran suggested that the financial function provides a useful managerial model to emulate for the quality function both in terms of job description and organization. It is the operating department's responsibility to produce financial results, not the finance department's. Likewise, it should be the quality function's responsibly to coordinate activities relevant to quality. Continuing the analogy, Juran pointed out that the financial management function consists of (a) budgeting, (b) budget control, and (c) cost reduction. In generic terms, these three functions are concerned with (a) planning, (b) control, and (c) improvement. Juran suggested that quality management likewise should be organized into three equally important functions, (a) quality planning, (b) quality control, and (c) quality improvement. Table 1, based on Juran (1989) but adapted and modified, outlines the tasks and responsibilities of these three functions.

It may seem logical to implement quality planning before engaging in quality control and quality improvement. However, Juran suggested that it is more pragmatic to start with quality improvement. Any existing organization will be able to make substantial improvements right away with a small upfront investment. This will help establish quick wins and early employee buy-in. This is psychologically important for any change management program; see Kotter (1995). Nevertheless, we discuss below Juran's Trilogy in the logical order of planning, control, and improvement.

Quality Planning

To stay competitive, we must do more than just remove deficiencies. We must develop new products and services with new features that appeal to an evolving customer taste and continue to be better than the competitor's offerings. Moreover, we must do so without repeating the mistakes of the past and without designing deficiencies into the product (i.e., a product can also be a service or process). Juran motivated this, by the analogy of an alligator hatchery. If we are up to our waist in alligators, it is not enough to kill the alligators around us. We must also go after the production of new alligators, the alligator hatchery. In other words, at the product design stage we must proactively try to prevent the need for subsequent quality improvement.

Quality planning is the process of preparing the launch of new competitive products, services, and processes that meet customers' needs and expectations, minimize product and service dissatisfaction, avoid costly deficiencies, optimize company performance, and provide participation from those affected by the product or service. Quality planning is essentially a marriage of the traditional marketing function with the research and development or engineering design function assisted by the quality

TABLE 1 The Juran Trilogy Consisting of the Three Functions of Quality Planning, Quality Control and Quality Improvement. This Table is Based on Juran (1989, p. 22) but Modified and Adapted

Quality management: Juran's Trilogy		
Quality planning	Quality control	Quality improvement
Determine who the customers are; classify customer segments	Planning for control:	Establish infrastructure for improvement
Determine what the needs of each customer segment are	Develop an understanding of what needs to be controlled relative to customer needs	Identify improvement projects
Design products with features and specifications that satisfy the needs of the customer segments	Develop a process flow diagram	Establish improvement teams
Develop products and processes that are capable of delivering the product or service	Choose what and where to control; control points	Provide teams with resources, training, and motivation:
Develop metrics and control mechanisms for monitoring and control	Establish measures	Diagnose root causes
Provide training in the delivery processes	Establish goals and standards of performance	Find remedies; improve
	Executing control:	Establish controls to institutionalize and hold on to the gains
	Evaluate actual outcomes	Disband the team
	Compare actual outcome to goals	
	Take action on the difference	

function to provide tools, formal standards, measurements, and data on performance. In this view, Juran is even today at the cutting edge if not ahead of modern thinking relative to innovation and commercialization of new products; see, for example, Kotler (2003).

Typically, quality planning involves developing new or updating existing products to meet evolving market demands or take advantage of new or emerging technologies. Table 1 as well as Figure 3 summarize the steps of the quality planning processes.

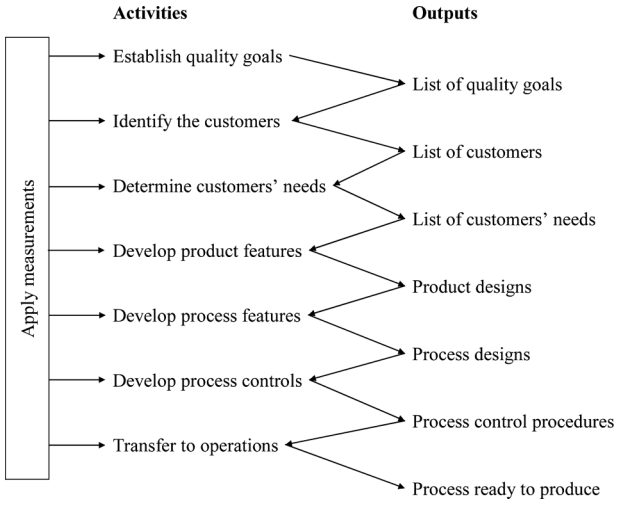

FIGURE 3 Juran's quality planning roadmap. Adapted and modified from Juran (1992, p. 20).

Quality planning starts with establishing a team project. Next, the cross-functional team needs to identify the customers, discover the customers' needs, develop the product or service, develop the process for the delivery of the product or service, develop the controls, and transfer to operations. Upper management must take responsibility for initiating, supporting, provide resources and monitor the quality planning process.

Quality Control: Managing the Control Function

The second function of Juran's Trilogy is quality control. Although control is related to the original inspection function and widely discussed in the statistical literature since Shewhart (1931), Juran has contributed profound managerial ideas to this area that we now review. The basic tasks of the control function are summarized in the center column of Table 1.

Figure 4 provides a systems diagram of the universal control function. A sensor evaluates actual performance. The actual performance is reported back to the umpire. The umpire compares the actual performance to the target (goal). If the difference is significant (i.e., larger than noise), the umpire orders a control action. The actuator makes the necessary changes to bring the process back on target (goal). This idea is applied universally at all levels of

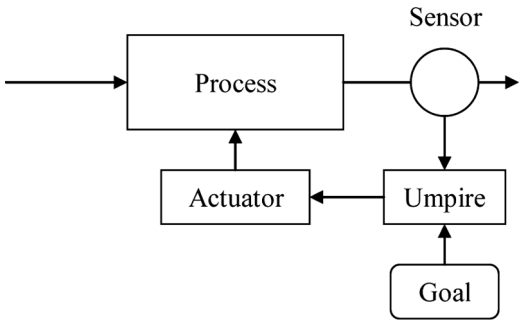

FIGURE 4 **The concept of process control.**

management. All employees, from the shop floor worker to the CEO, exercise control. The difference is the subject and scope of control. Workers typically control product and process features. Executives control budgets, sales, etc.

The above concepts are basic engineering control theory. Nothing new here! Juran's contribution has to do with the management of the control function, the distribution of authority, and responsibility, a topic rarely discussed in the statistical process control literature. We already mentioned that traditional quality control by inspection carried out by a separate inspection department tends to develop an unhealthy transfer of the responsibility from the producer to the inspector. That approach has proven ineffective. The issue of separation of authority from responsibility however applies more generally, not just to the shop floor inspection function. Juran pointed out that necessary criteria for what he termed "controllability" of a process are (1) knowing what the goals are; (2) the ability to know what the actual performance is; and (3) having means for and authority to change the performance when the process does not conform to goals or standards. Without these three criteria fulfilled, a person cannot fairly be said to be in control. Ideally, responsibility for control should be assigned to individuals and combined with authority. Indeed, to hold someone responsible in the absence of controllability is bad management. A test for completeness of planning for control is to check whether the three criteria for controllability are met.

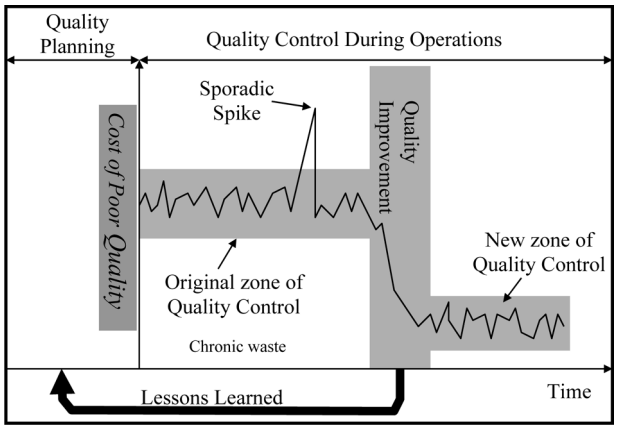

FIGURE 5 **A graphical depiction of the Juran trilogy, adapted from Juran (1989).**

It is interesting to note that Juran's principle for controllability is parallel to management expert Peter Drucker's notion of self-control; see Drucker (1954, pp. 130–132). Drucker explains that control can mean (1) ability to direct oneself and one's work or (2) domination of one person by another. The objective of management control should be the ability to direct oneself and one's work! Drucker claims that it is a major objective of modern management to substitute management by domination with management by self-control. However, to make management by self-control a reality requires more than saying that it is desirable. It requires new tools and far-reaching changes in traditional thinking and practices. A manager needs to know his goals, be able to measure his performance and results against goals, and have the authority to make changes. Each manager should have the information needed for control and receive it soon enough to be able to make necessary changes for achieving the necessary results. The information should go to the manager himself, not to his superior. Measurements should be a means of self-control, not a tool of control from above. If information technology is abused to impose control on managers from above, it will inflict harm by demoralizing management and by lowering the effectiveness of managers. Enlightened management will primarily rely on self-control and personal responsibility. Thus, Drucker's notion of self-control is parallel to Juran's controllability.

It is also interesting to note that the idea of controllability is related to Shewhart's and Deming's notions of special causes and common or systems causes. Special causes are those the operator can control, is responsible for, and have the authority to change. Systems causes are causes inherent to the system that only management can control and

have the authority to change. Hence, systems problems should be the responsibility of upper management, not lower level workers. Anything else is unfair, unreasonable, and counterproductive; see Deming (1986).

Quality Improvement

We now consider Juran's insight to how to organize and implement quality improvement. In Juran (1993), he explained how he personally came to realize that quality control without quality improvement was ineffective, if not futile. He related the story about a Western Electric production process of a certain circuit breaker produced in large volume where the defect rate was 15%. A statistical investigation revealed that the copper wire exhibited excessive variability from coil to coil, causing many out of spec products. A remedy was subsequently developed to compensate for the excessive variability. Eventually this problem was permanently removed and the defect rate reduced virtually to zero. Thus, rather than a chronic waste of 15% of labor cost, materials, and costly inspection, the cost of poor quality was essentially permanently eliminated. Guided by this watershed experience, in 1954 Juran explained to Japanese executives that if they were serious about quality, they should not just rely on inspection and quality control. Rather, they should aggressively pursue a strategy of quality improvement by permanently removing chronic problems and waste. Such a strategy would have an extraordinary return on the investment, he promised. However, it would require the executives to be involved, make quality a strategic issue, break down barriers between departments, and make quality a company-wide effort.

It is likely that Juran was not the first to recognize that quality improvement needs to be done via special projects. However, his declaration that "Quality is improved project-by-project and in no other way" sums up his point. He has more succinctly than anyone formulated the basic principles for how to implement and organize for quality improvement.

Juran outlined a universal roadmap for quality improvement that is analogous to detective work. The initial steps are first to gather information on needs, for example, on a cost-of-poor-quality basis, then proceed to identify potential projects and select projects, for example, based on a cost-of-poor-quality ranking, and finally organize project teams. Once the project teams are formed, they are required to follow a six-step road map: (1) review that the chosen project is important, (2) define the project mission and objective, (3) diagnose root cause(s), (4) develop a remedy and verify its effectiveness, (5) deal with organizational resistance to change, and (6) institute controls to hold the gains. Anyone familiar with Six Sigma will recognize this as a generic version of the Define, Measure, Analyze, Improve, and Control (DMAIC) framework.

Upper Management Responsibilities

Like many other consultants in quality management, Juran no doubt repeatedly experienced that unless upper management were fully involved and onboard, any long-term effort is futile. For executives to just pronounce support and walk away is not enough. Upper management must be thoroughly engaged throughout the journey. But what does that mean? Unlike many quality consultants who just voiced frustration, Juran proceeded to be prescriptive and explain in detail what top management involvement ought to mean.

The first step is to establish a quality council. A quality council is a group of top executives and upper managers that develops the quality strategy and guides and supports the implementation. The responsibility of the quality council is to launch, coordinate, and institutionalize annual quality improvement goals and plans. The council formulates policies and improvement priorities, establishes metrics, establishes a project nomination and selection process, establishes a team selection process, provides resources, assures implementation, establishes needed benchmarks to gauge progress, establishes a progress review process, faces up to employee apprehension from workers made superfluous, retrains or reassigns workers, provides recognition, and revises the reward system to accommodate for quality.

Councils may be established at several organizational levels. Large companies may establish councils on division as well as at corporate levels. At any level, the membership should consist of upper managers from line and staff. Members of higher levels

often chair lower level councils. Senior manager membership is a must. Otherwise, only "useful many" type problems are solved, not the "vital few" that produce the greatest return.

According to Juran, the chairperson of the councils should be the manager with overall responsibility and authority for the unit. One member of the council should be the director of quality. However, this structure, although logically sound, may need modification. For example, General Electric (GE) has found that senior managers may not necessarily have sufficient skills and background in quality management to effectively head a quality council. Instead, GE has successfully experimented with having professionally trained quality leaders head the councils. However, the senior manager's membership, presence, and support on the council were found to be critical for success. This modified structure is not unlike what is common practice in financial management where it is typically the CFO and not the CEO who heads up the finance committee.

Terminology

A more subtle but important contribution to quality management is Juran's work on definitions and terminology. Any scientific field requires its own precise and well-defined terminology. Terminology and definitions are fundamental to any science. Without it, confusion prevails. For example, a lay person will not be particularly careful about using "heat" and "temperature" synonymously. However, a well-trained physicist, chemist, or engineer would be abhorred. For them these terms have precise and very different meanings.

In the honorable scientific tradition of the French chemist Lavoisier and the English physicist Faraday, Juran recognized that for the nascent science of quality management to become on a sound footing, he needed to develop terms and define new concepts. For example, as we already alluded to Juran pointed out that "cost of quality" was an ambiguous term. The cost-of-quality concept is too confusing and difficult to narrow down. It fails to distinguish between the cost of providing quality features and the cost of deficiencies. Cost of poor quality, on the other hand, can be precisely defined as the sum of all costs that will disappear if the deficiencies are removed.

We already discussed Juran's definition of quality and its two subsidiary definitions. However, he defined many other important terms. For example, he defined the meaning of customers, processors, and suppliers and explained how these three combined play a universal role in any process. Thus, he called this triple role "Triprol." For more, see Juran and Godfrey (1999).

CONCLUSION: AN APPRECIATION OF JURAN'S IMPACT NOW AND IN THE FUTURE

According to the economist Schumpeter (1950), in a free market, economic reality is distinguished by competition from new commodities, new technologies, new sources of supply, new types of organization—competition that commands a decisive cost or quality advantage. Innovation-based competition is extremely effective and strikes not at the margins of existing firms but at their foundations and threatens their survival. New innovations render older innovations obsolete. Schumpeter (1950) referred to this as "the perennial gale of creative destruction."

Quality is about innovation—innovation of better products, better services, better processes, and better organizational structures. We used to think of quality as only related to deficiencies and only related to production floor problems. Modern quality management defines quality more broadly as "fitness for use" with the subsidiary meaning of features and deficiencies. This expanded definition puts the customer front and center and implies the need for developing innovative ways to retain existing and attract new customers with competitive market offerings. Improvements aimed at eliminating chronic sources of deficiencies from products and processes are innovations that reduce cost and improve our competitive position. But we cannot only rely on reducing deficiencies. We must also compete on product innovations that involve new features—design and develop new products or services that provide better value to the customers—market offerings that better solve the customer's problems. Juran (1989) called the process of innovating new market offerings "quality planning." In Six Sigma terminology this is called "Design for Six Sigma" (DFSS), but the

concept is the same. From this perspective, quality management is a systematic and well-organized approach to managing the process of designing and developing process and product innovations. Rather than hoping for haphazard occurrences, quality management puts innovation on a schedule and provides the organizational framework for managing innovations, large and small.

Juran's Trilogy is a system for managing not just quality but more general for managing innovation. His teaching provides us with a practical and comprehensive framework for managing innovations. Juran tells us what to do. His writing provides hands-on operational information about how to go about organizing and implementing a quality management program within an organization. In many aspects, Juran was ahead of his time.

If we should be critical of Juran it would be relative to his impact. Many of his ideas are still seldom used and are waiting to be "discovered." Although he wrote many books and publications, we attribute his lack of widespread popularity and impact especially among managers to his somewhat arduous engineering style of writing. Juran is not easy reading, but patience makes it highly rewarding. The irony is that what has made his contributions to quality management so important, namely his precise and detailed writing style, has perhaps also turned off the larger population of managers for whom quality management is so essential. We even suspect that few Six Sigma practitioners are familiar with his work. Indeed, in some areas, Six Sigma is still trying to catch up with or reinvent Juran's ideas. For example, Six Sigma does not yet adequately account for the quality control function. Juran's concept of quality planning also appears to be much more comprehensive than the current design for Six Sigma concept. Moreover, we find that in most areas of quality management Juran is far better articulated about fundamental principles.

Another criticism that arguably may not be widely share is that Juran never took a strong position relative to the ISO 9000 standardization movement. We share with Juran a sincere appreciation for the importance of standardization in general. We also appreciate that in his role as the Nestor of the quality movement, he may not have wanted to be perceived as causing dissention. We also feel confident that ISO 9000 initially was well intended. However, in our judgment the effect has been a diversion away from a forward looking business focus—improving quality and satisfy customers—to a defensive focus on satisfying self-appointed quality auditors to pass a certification with what sometimes more looked like Potemkin village contrivances. Indeed, we feel that ISO 9000 has had a corrupting effect on the quality movement, especially in Europe.

In fairness Juran (1995, p. 595) did write that:

> The ISO standards have a degree of merit. The criteria define a comprehensive quality control system. The certification process may well get rid of the plague of multiple assessments which have burdened suppliers in the past. However, the criteria fail to include some of the essentials needed to attain world-class quality, such as personal leadership by the upper managers; training the hierarchy in managing for quality; quality goals in the business plan; maintaining a revolutionary rate of quality improvement; participation and empowerment of the workforce.
>
> All in all, there is a risk that European companies are in for a massive let down. They are getting certified to ISO 9000, but this alone will not enable them to attain quality leadership.

We wish Juran would have been willing to be more outspoken and publicly against ISO 9000 from the start. It will take time to recover. Six Sigma, with its business focus, is a good start. Lean Six Sigma is perhaps what will help the quality movement regain credibility among upper managers especially in Europe.

To sum up, quality engineers and statisticians involved with quality will be more effective if they also concern themselves with the managerial environment in which they operate and apply their tools. There may be alternative systems for quality management, but Juran's trilogy is in our opinion comprehensive and effective. Moreover, his hands-on advice about going about organizing the quality function and how to involve upper management is unsurpassed. We hope this article will inspire quality professionals to revisit the extensive Juran literature.

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