The Paradigms of Quality:
Evolution and Revolution in the History of the Discipline

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Abstract

The quality of goods and services has always been a societal concern. In this paper I describe the evolution of the discipline of *quality* via an evolutionary model of paradigm development. Using a narrative approach, I propose three epochs within the evolution of the discipline: a pre-industrial paradigm of *caveat emptor*, an industrial paradigm of *quality control*, and a post-industrial paradigm of *total quality management*. My model suggests that each paradigm was the result of the discipline's adaptation to environmental contingencies. I also propose that the essential nature of the paradigm was foreshadowed in the previous epoch as a local variation which was later selected globally when evironmental changes occurred. I extend the model to predict what might constitute the challenges of the next quality paradigm.

Introduction

Society has always been concerned about the quality of the goods and services provided to them. For the lack of poor quality, a house might have fallen on its ancient inhabitants, a fishing ship may have sunk while at sea, or a battle may have been lost due to arms that would not work. Over the ages though the concept of *quality* has developed into a discipline, a complex set of principles and assumed truths that define how the quality of goods and services is to be assessed, managed, delivered and assured.

The purpose of this paper is to describe the evolution of the discipline of *quality* via an evolutionary model of paradigm development. The evolutionary model posits that the tenets of the discipline are the result of adaptation, namely, that the conditions present in a given era of time shape the nature of the discipline. Using a narrative approach, I propose three epochs within the evolution of the discipline. The first paradigm of quality, present from ancient times until the industrial evolution, is best desribed by *caveat emptor*. Artisans produced goods of certain quality and it was up to the consumer to appraise the quality of these goods. The reputation of the artisan was at stake for those quality characteristics that could not be ascertained in a manifest way, i.e. latent quality attributes of the product. Trademarks, guilds, and punitive measures were used to extend *caveat emptor* to situations where it was not feasible.

The industrial evolution raised the level of product and process complexity, and hence a new quality paradigm of *quality control* was borne, coinciding with a broader set of changes taking place under the realm of scientific management. Out of this came the development of basic quality practices such as sampling inspection, the use of statistical methods within a framework of scientific management, standardization, and a functionalization of the discipline. Much of the twentieth century was spent developing the techniques of *quality control*. During the latter part of the twentieth century global competition forced organizations to become equally concerned about the improvement of quality as they had been about the control of quality, hence a third paradigm arose, that of *total quality management (TQM)*. *TQM* brought the awareness and practice of quality principles to a new level, and emphasized such things as organizational learning and participative management.

Furthermore, the paradigms of *quality control* and *TQM* can be seen as having been foreshadowed as niche responses to local environmental contingencies in the previous paradigm. During the epoch of *caveat emptor*, elements of the *quality control* paradigm can be seen in more

advanced cultures such as the Chinese dynasties and the Roman Empire with the arising of standards regarding the quality of goods, and the emphasis on standardization, conformance, and control in complex military systems. During the epoch of *quality control*, elements of the *TQM* paradigm can be seen in the development of Japanese-style quality control, and in the writings of Juran and Feigenbaum. Each of these local variations was later selected when evironmental changes occurred.

I shall first present the evolutionary model and address the basic issues involved in the study of a paradigm and discipline. I will then present a narrative history of the discipline's evolution, using the model as a theoretical template, or lens. I will then extend the model to predict what might constitute the challenges of the next quality paradigm.

Paradigms and Disciplines

Thomas Kuhn's (1970) work on scientific paradigms is our starting point. At the heart of Kuhn's argument is that at a given epoch of time, a paradigm, or set of shared principles and assumptions, defines what is "normal science"; and that normal science describes the vast majority of work within that era. For example, Newton's laws of motions defined the paradigm of astronomy for several centuries, until the discovery of relativity. Kuhn asserts that scientists spend little effort in examining issues that are outside the paradigm, and that most work is focused on refining the theories essential to the paradigm and problem solving within the paradigm. Kuhn points out that work that is critical of the paradigm's principles and assumptions is typically ignored, criticized, and/or subsumed to be due to special circumstances. For example, there was little sympathy for theories concerning a sun-centric solar system within an earth-centric astronomical paradigm. It is only when great anomolies occur between observation and theory that a paradigm can be replaced by another. Thus paradigms can be thought of as evolving via a model of punctuated equilibrium, where long periods of slow evolutionary change are interrupted by short periods of revolutionary change (Gersick, 1991).

Even though Kuhn's work focused on paradigms pertaining to scientific research, the concepts appear to easily "stretch" to a more generalizable context, namely, a discipline based on a community of practice (Brown and Duguid, 1991). According to institutional theory, a discipline in fact is a highly developed, culturally-based entity that acts as a paradigm. A discipline is a very important phenomenon to study because “disciplines rule by controlling

belief systems. Their primary weapons are ideas. They exercise control by defining reality--by devising ontological frameworks, proposing distinctions, creating typifications, and fabricating principles or guidelines for action" (Scott and Backman, 1990, p. 290). Further, "disciplines tell actors which problems should be addressed, how they should be addressed, and what their outcome should look like. As such, they define both a frame of mind (cognitive) as well as a frame of action (normative)" (Dooley, Durfee, Shinde, and Anderson, 2000, p. 289).

We can use evolutionary theory (Cohen and Stewart, 1994) to develop a model of how a discipline might evolve over time. First is the notion of environmental adaptation--an entity will evolve characteristic traits that make it "fit" well with the current environment. Thus, we would expect the characteristics of a discipline--what it believes is important, how reality is observed and modeled, what actions are prescribed--to fit well within the historical environment within which it is embedded. Since the discipline of quality is essentially concerned with commerce and industry, that is the environment to which it has historically adapted.

The second element of the model is local variation due to niche environmental conditions. An entity will attempt to adapt to whatever environment it faces, regardless of whether the environment is uniform on a global basis, or heterogenous and highly local. Thus differences between the local and global environment may give rise to adaptations that only take place locally. These adaptations are beneficial locally, but not globally, and so they remained contained within a small niche of the larger population. When we apply this concept to a discipline, it implies that a discipline may be practiced differently in certain locales than in others, due to local contingencies. The discipline of quality, while relatively uniform within a given epoch of time, has had such local variations.

The final element of the model ties together the first two, namely, that a revolutionary change in the paradigm or discipline can take place when environmental conditions change drastically, and that it is one of the local niche variations that is likely to be selected as a new global adaptation. Thus the discipline is thought to leapfrog from one paradigm to the next by selecting some variation of itself that has arisen due to previously local (only) environmental pressures. In summary, the model proposed is:

1. The discipline of quality at a specific epoch in time reflected the business environment of that epoch.

2. Variations in the practice of the discipline occurred under special (local) circumstances.
3. These variations were later selected, retained, and developed when the business environment changed drastically.

I propose that the discipline of quality has seen three iterations of this model: a pre-industrial paradigm of *caveat emptor*, an industrial paradigm of *quality control*, and a post-industrial paradigm of *total quality management*. I shall now use a narrative approach to describe each of these paradigms.

The Paradigm of Caveat Emptor

In a pre-industrial era, the quantity and quality of goods were the two essential characteristics defining an economic transaction. According to the seventeenth century economist Nicholas Barbon, "The qualities of wares are known by their colour, sound, smell, taste, make, or shape. The difference in the qualities of wares are very difficultly distinguished; those organs that are the proper judges of those differences, do very much disagree; some men have clearer eyes, some more distinguishing ears, and other nicer noses and tastes; and every man having a good opinion of his own faculties, it is hard to find a judge to determine which is best" (Barbon, 1690). Barbon considers quality to be subjective and experiential.

The concept of quality in this era was transcendental, related to the philosophical concept of qualia, akin to Plato's concept of "beauty"--we know it when we see it (Garvin, 1988). Quality was thought of as an instantaneous phenomena, arising from the basic senses. As Pirsig's hero Phaedrus relates "Quality doesn't have to be defined. You understand it without definition, ahead of definition. Quality is a direct experience independent of and prior to intellectual abstractions" (Pirsig, 1991, p. 64).

These *qualia* are experienced in two ways: immediately (manifest characteristics) and through use (latent). Barbon adds: "Besides, those qualites that belong to artificial wares,such as depend upon the mixture, make or shape of them, are more difficultly discovered: those wares, whose quality are produced by the just mixture of different bodies, such as knives and razors, whose sharpness arise from the good temperament and mixture of the steel & iron, are not to be found out, but by the use of them: and so doth the mixture, and well making of hats, cloth, and many other things" (Barbon, 1690).

Bigliazzi and Mirandola (1995, p. 185-86) quote anicent Roman writer Vitruvius concerning how this was operationalized in ancient Rome: "Unfortunately it is impossible to assess the quality of baked bricks beforehand. They have to be laid: if they are of good quality they will withstand storms and the heat of the summer; but if they have been made from unsuitable clay or if they have been insufficiently baked, then they will reveal their defects. Therefore it is best to build roofs from old tiles; then the walls too will certainly be solid."

Thus the consumer was responsible for assuring the quality of the goods they purchased--in essence, *caveat emptor*. The concept of caveat emptor, or "let the buyer beware", has roots in English common law (and certainly predates that). For perishable goods such as foodstuffs whose quality characteristics are manifest, *caveat emptor* was feasible and practical. In Germany, food vendors and other craftsmen such as shoemakers or coopers were required to locate next to one another, presumably so consumers could directly compare the quality of goods to one another in a facile manner (Lerner, 1995); no doubt the lay-out of the common marketplace or bizarre served much the same function.

For those manufactured goods whose quality characteristics were primarily latent, a different kind of social contract was needed to ensure quality. Barbon relates "Because the difference in the qualities of wares, are so difficultly understood, it is that the trader serves an apprendiceship to learn them; and the knowledge of them is called the mystery of trade; and in common dealing, the buyer is forced to rely on the skill and honesty of the seller, to deliver wares with such qualities as he affirms them to have: it is the sellers interest, from the expectation of further dealing, not to deceive; because his shop, the place of dealing, is known: therefore, those persons that buy of pedlars, and wandering people, run great hazard of being cheated. Those wares, whose chief qualities consist in shape, such as all wearing apparel, do not so much depend upon the honesty of the seller; for though the trader or maker, is the inventor of the shape, yet it is the fancy and approbation of the buyer, that brings it into use, and makes it pass for a fashion" (Barbon, 1690).

Thus the science of the manufacture, the "mystery of the trade", became an important element in providing quality goods. The passing down of this procedural knowledge through an appreticeship became a mainstream component of medieval society. In many European countries guilds were formed that formalized the profession and its embedded expertise. The expert knowledge remained primarily tacit however. As Conterio and Da Villa (1995, p. 332) relate

regarding shipbuilding in Venice, "The actual quality of the finished ship depended largely on the skill of the men who built it. The shape and dimensions of the ships originated largely in the minds of carpenters and caulkers, who passed on their skills from generation to generation, sometimes recording knowledge in written form. There was no school to teach them their trade--all their knowledge was acquired through years of experience and practice. In short, the entire shipbuilding industry was based on the eye and experience of the master craftsman."

While standards existed for the measuring quantity of items (an essential element of commerce), standards for quality were less prevalent. As George (1968, p. 50) states, during the industrial revolution in the nineteenth century "quality control... was little, if any, improved over the previous systems. Products continued to be made from non-standardized materials using non-standardized methods, thereby resulting in products of variable quality. The only real standards used were measures of dimensions, weights, and in some instances, purity. The most common form of quality control was the inspection of the product by the purchaser, under the Common Law rule of *caveat emptor*".

Caveat emptor was not feasible in all situations. For more complex products it was not feasible for the consumer to observe quality prior to purchase. Two mechanisms arose for extending *caveat emptor* to such situations. First, punitive actions were taken against those craftsmen or workers who produced poor quality work. For example, The Code of Hammurabi (Babylonia) from 2150 B.C. states: "If a builder has built a house for a man, and his work is not strong, and the house falls in and kills the householder, that builder shall be slain" (Harper, 1904). In Germany, "bakers who reduced the weight of bread, cakes, and pastry were punished by being locked up in a basket and lowered into the river in front of the whole town (Lerner, 1995, p. 218). In India, punishments were primarily financially-based (Goswamy, 1995). In Russia, Peter the Great made the following decree in 1723: "If a stoppage occurs among the troops during combat due to oversight by the secretaries and sriveners, the latter should be flogged on their naked parts without mercy. The master gets 25 whips and a fine of 10 rubles per faulty gun. The foreman should be flogged until he loses consciousness…The secretary of the rank should be stripped to become a copier. The scrivener should be denied his Sunday glass of vodka for one year" (Konareva, 1995, p. 390).

The second mechanism was marks, or trademarks. In China, as early as 300 B.C. the names of craftsmen, slaves, and officials were inscribed in weapons to ensure traceability of poor

product (Quipeng, Meidong, and Wenzhoa, 1995). This in fact ensured that the previous mechanism, punitive action, could be used. These marks became more than just tracers, however; they became a source of pride. In Germany, marks began to be used extensively on everything from weapons to stonemasonry to clothing in the fourteenth century; this also had "supply chain" implications, as for example clothiers could purchase material and use it without prior inspection, due to the validation of its quality via its mark (Lerner, 1995). As these marks were developed and coupled with trades, they quite literally became "trademarks" and were a source of great professional pride. Given the importance and continued evolution of marks in Europe, the importance of the "ISO 9000 mark" in the twentieth century should have come as no surprise.

C*aveat emptor* can be seen as an adaptation to the business environment, which consisted primarily of products whose attributes were mainly manifest and thus could be directly observed upon purchase by the consumer, and little complexity in terms of variation and volume of product. For those items that were more complex, the expertise of the artisan, operationalized through trademarks and punitive actions, was the primary quality assurance mechanism.

In ancient times one can see that in some complex societies, community-based standards for quality were developed. The Zhou dynasty of China (approx. 1000 B.C.) decreed "utensils under standards are not allowed to be sold on the market; carts under standard are not allowed to be sold on the market; cottons and silk of which the quality and size are not up to standards are not allowed to be sold on the market" (Juran, 1990, p. 32).

Another "local variation" that predated the era of *quality control* but had many of its elements were military systems that emphasized standardization, control, and conformance. In ancient Rome, standardization took place in measurement systems, normalization of the size of basic items like bricks and pipe, morphological normalization in the design of buildings, and building regulations regarding the quality of housing and housing material (Bigliazzi and Mirandola, 1995). Military management was responsible for much of the early emphasis on standard practices as a means to achieve quality. Romans of the sixth century had developed strict rules concerning the exact and precise ways in which soldiers should arrange their articles of equipment and clothing (Spaulding, 1937). The management system responsible for the arsenal of Venice in the fifteenth and sixteenth centuries employed such concepts as piecework pay for satisfactory work, self-inspection by artisans, inspection by foreman, apprentice

examinations, and standardization of designs (Lane, 1934; George, 1968). Such quality systems were the exception, however--nevertheless, they were a precursor of what was to come.

For example, the nineteenth century economist Charles Babbage foresaw many of the changes that loomed ahead. Even though it was not until Frederick Taylor made explicit such principles almost a century later, Babbage foreshadowed some of the aspects of *quality control* that the industrial age would become concerned with: "Outlines of a description of any of the mechanical arts ought to contain information on the following points… To what defects are the goods liable? What substitutes or adulterations are used? What waste is allowed by the master? What tests are there of the goodness of the manufactured articles? The weight of a given quantity, or number, and a comparison with that of the raw material? Who provide tools? Master, or men? Who repair tools? Master, or men? What is the expense of the machinery? What is the annual wear and tear, and what its duration? Is there any particular trade for making it? Where? Is it made and repaired at the manufactory? … Whether the same article, but of superior, equal, or inferior make, is imported?" (Babbage, 1832).

The Paradigm of Quality Control

A discipline does not shift to a new paradigm at some discrete instance in time; rather, change takes place relatively rapidly over a period of time (Kuhn, 1970). Thus it is impossible to pinpoint a single reason, or cause, for a paradigm shift. However, a collection of events can be identified that signify significant change and departure from the existing paradigm.

The industrial revolution and the factory system gave rise to increased product and process complexity and hence difficulties with the control of quality, cost, and inventory--it is the factory that literally caused a revolution in how the discipline of quality was practiced. The discipline of quality was not unique in this regard; all aspects of organizational management evolved. Issues of complexity, control, and motivation were met with new management systems which invoked division of labor and separation of labor and management, piecepay compensation schemes, and eventually, the system of scientific management. Richard Arkwright, Sir James Steuart, and Adam Smith were among the first advocates of such new systems (George, 1968).

Individual motivation was seen as a key to process improvement: "Set a man to labor at so much a day, he will go on at a regular rate, and never seek to improve his method: let him be

hired by the piece, he will find a thousand expedients to extend his industry" (Steuart, 1767). The division of labor was seen as a means not only to improve productivity but also process quality: "...if anyone confines himself to a small number (of tasks) he will perform them with much more rapidity, but, what is of higher consequence, with greater correctness and precision" (Mill, 1826); and as a means to improve pride of work: "(Use a beneficial suggestion system because) every person connected with it should derive more advantage from applying any improvement he might discover" (Babbage, 1832).

The introduction of interchangeable parts placed even more emphasis on uniformity of product. Thomas Jefferson describes the application of the idea to muskets: "...It consists in the making of every part of them exactly the alike, that what belongs to any one, may be used for any other musket in the magazine" (Durfee, 1894). Shewhart alludes to the establishment of one-sided tolerance limits in (approximately) 1840 and two-sided limits in 1870; conformance to such limits could be mechanically checked by "go-no go" gauges which meant that "All he had to do was stay within tolerance limits--he didn't have to waste time trying to be unnecessarily exact" (Shewhart, 1939, p. 3).

Frederick W. Taylor was responsible for taking the management ideas that had preceded him and synthesizing them into a coherent *management philosophy*, and as such, his principles of scientific management form the basis of most management practice in the twentieth century. As an engineer with Midvale Steel in the late 1800's, he observed the typical problems that plagued organizations: unclear responsibilities, little standardization, no incentive for performance, systematic "soldiering", decisions based on rule of thumb, no training, and finally "that management apparently disregarded the obvious truth that excellence in performance and operation would mean a reward to both management and labor" (George, 1968, p. 90). By 1911 he had developed these ideas into four key managerial principles: (a) develop a science for each man's work, (b) train and develop the workman, (c) heartily cooperate with others, and (d) divide work and responsibility between labor and management (Taylor, 1911).

Taylor emphasized the systemic nature of these principles and warned against confusing the managerial philosophy with the common tools associated with scientific management, such as time study, standardization, compensation schemes, and modern cost systems, etc. (George, 1968). One should note the similarity between Taylor's concern with that of W. Edwards Deming, who has contended that management seeks "instant pudding" through its concern over

statistical process control, quality circles, etc. without understanding the management philosophy as a system: "You can install a new desk, or a new carpet, or a new dean, but not quality control. Anyone that proposes to 'install quality control' unfortunately has little knowledge about quality control. Improvement of quality and productivity, to be successful in any company, must be a learning process, year by year, top management leading the whole company" (Deming, 1986, p. 133). Taylor's principles of scientific management are responsible for many of the management practices that organizations follow today: research, standards, planning, control, and cooperation.

Organizational structures correspondingly changed as a result of division of labor and scientific management. At the turn of the century inspectors worked along side workers under production foreman. This set up a conflict, however, as productivity was the first priority of the production foreman, and quality suffered. Blame for poor quality was likely to go from the inspector to the foreman and back to the workers, thus making inspection an enemy of production. Much unfit material was delivered to military customers during World War 1 because of this structure, and many firms took the inspectors out of production's control and put them under inspection foremen and a chief inspector (Juran and Gryna, 1980). This was the beginning of the "quality control" department, which was to be the cornerstone of management of quality for decades to come. The central inspection department was responsible for such functions as vendor inspection, process inspection, final inspection, measurement laboratories, and salvage.

These revolutionary changes in the work environment led to a new paradigm of the quality discipline that we shall entitle *quality control.* Unlike its predecessor paradigm, the responsibility for controlling manifest quality characteristics shifted from the consumer back to the producer, and it became systematized and functionalized (like everything else in early twentieth century organizational management). The inception of the Inspection Engineering Department at Western Electric's Bell Telephone Laboratories (Hawthorne Works) in 1924 marked the beginning of a new era in the management of quality. Among the department's members were Walter Shewhart, Harold Dodge, George Edwards, Joseph Juran, and Harry Romig. Out of this group came many of the singular contributions to the practice of quality control and management: acceptance sampling, statistical process control, and the responsibility of management.

Edwards coined the term "quality assurance" and advocated quality as part of

management's responsibility (Gitlow, Gitlow, Oppenheim, and Oppenheim, 1989): "...It puts a man at the head of the quality control program in a position to establish and make effective a company-wide policy with respect to quality, to direct the actions to be taken where it is necessary and to place responsibility where it belongs in each instance" (Harrington, 1983, p. 8). Dodge, Romig, and Walter Bartky developed the concepts and tools of statistical sampling plans for the enumeration of product quality between 1925 and 1926, defining and operationalizing concepts such as: producer and consumer's risks, probability of acceptance, operating characteristic curves, lot tolerance percent defective and average quality limits, average total inspection, and double sampling. Dodge and Romig first published their sampling plans in 1929 (Dodge and Romig, 1959). At the same time Shewhart was developing the concept of control charts for the identification of process variation and stability, with the publication of his text coming in 1931 (Shewhart, 1931). Kuhn notes that the establishment of written standards and textbooks are often the first signals that a paradigm has formed, and that "normal science" is being performed. The content of Shewhart's book define the quality profession as primarily one of employing statistical methods and keeping historical records.

The focus of the management of quality in the 1930's was essentially along the lines of establishment of several societies and standards. Shewhart began the *Joint Committee for the Development of Statistical Applications in Engineering and Manufacturing* in 1929 (Olmstead, 1956), and in 1930 the *American Society for Testing and Materials* formed a Committee on the Interpretation and Presentation of Data (Industrial Quality Control, 1967). This provided an opportunity to disseminate his ideas to a broader audience (Booth, 1964), which included lectures at University College in London (Simon, 1949). The British Standards Number 600 entitled "Application of Statistical Methods to Industrial Standardization and Quality Control" was established in 1935, and the U.S. Food, Drug, and Cosmetic Act of 1938 established quality standards for a broad range of consumer products (Banks, 1989). In Europe, the German Standards Committee was formed in 1926 (Lerner, 1995), and the British Standards Institution was formed in 1931 (Hutchins, 1995).

World War II had a profound impact on the practice of quality in organizations in the U.S., and eventually, globally. Prior to the war, the U.S. government assured procured quality via inspection and test of conformance to specifications. The same approach was retained for the war, only now greatly increased volume strained the quality assurance system. The

government's solution was to begin to rely heavily on acceptance via sampling inspection, and set forth to produce standards for such (Juran, 1991). The "Guide for Quality Control" (Z1.1-1941), "Control Chart Method for Analyzing Data" (Z1.2-1941), and "Control Chart Method of Controlling Quality During Production" (Z1.3-1942) standards were established for process control, and Edwards, Dodge, Romig, and Gause established the Armed Service Forces tables for sampling inspection in 1942 (later to be established as MIL-STD-105D) (Wareham and Stratton, 1991).

Courses were established to teach military suppliers how to implement these standards, and a model course developed at Stanford was adopted by the Engineering, Science, and Management War Training program, overseen by the War Production Board. Holbrook Working, a Stanford professor and key instructor in the program, estimated 7553 people went through the Stanford courses alone, receiving 409,000 hours of instruction (Wareham and Stratton, 1991). Approximately 31,000 students went through statistical quality control training of some sort during the war (Walton, 1986). Eugene Grant, also one of the instructors, credits the formation of the *American Society of Quality Control* to the gathering of quality professionals during these training sessions and subsequent follow-ups (Grant and Lang, 1991).

The great influx of newly trained quality practitioners changed once again the organizational structure designed to manage quality. New procedures included company quality control manuals, in-house statistical training, quality data systems, formal problem solving approaches, measurement standards, quality audits, and quality reports. Soon after reliability engineering also became recognized as being an important task. The carrying out of these new functions became the task of the "quality engineer", and the associated quality control department, which now held a status higher than had ever previously been the case. The quality control department eventually gave way to the quality assurance department, which typically had elevated status and reported directly to the vice president of manufacturing (Juran, 1991). This influx of quality practitioners due to the war time efforts, and the subsequent organizational changes that ensued, can be seen as a local variation that was later selected for on a global basis during the next paradigm.

One must certainly question why such wide-spread training and application of modern statistical methods did not have more of a profound impact on industry. The answer may partially lie in the composition of those war-time classes: "The top executives could usually not

afford to attend an eight day course..." (Wareham and Stratton, 1991, p. 39). W. Edwards Deming, one of the program's instructors and a student of Walter Shewhart's, also observed the releative ineffectivness of the wartime training, and this became a theme in his later teachings.

Juran also states several reasons for the decline of statistical quality control in the 1950's. First, the control chart applications were not appealing to upper management since they only dealt with the sporadic problems and not the chronic waste upon which bottom line results depended. Secondly, the task of process control was not one in which the worker or foreman was involved, thus allowing a disassociation of the activity. Lastly, when recession came, companies downsized their quality control groups, which had been previously funded on a cost-plus nature by the defense department (Juran, 1991). In summary, the discipline began to evolve beyond the paradigm of quality control, but the business environment was not supportive of or ready for such development.

During this era of *quality control* quality experts such as Edwards, Juran and Feigenbaum were vocal in their call for management to be more responsible, and responsive, to the topic of quality. Juran stated "It is most important that top-management be quality minded. In the absence of sincere manifestations of interest at the top, little will happen below...The interest of top management usually stems from the desire to achieve a good quality reputation among the consuming public...What is too frequently not realized is that the achievement of such quality reputation requires that the idea--the propaganda--permeate the entire organization" (Juran, 1945). Feigenbaum also echoed the importance of management commitment: "I submit that to enable Quality Control to be really effective as a long rather than short term matter...we must work on making Quality Control a member of the regular management team" (Feigenbaum, 1952). The publication of Juran's first edition of the Quality Control Handbook (Juran, 1951a) and the beginning of the "Management's Corner" column in *Industrial Quality Control* in 1951 (Juran, 1951b) continued to espouse the importance of planning in the management of quality (DelMar and Sheldon, 1988), though it was not until thirty to forty years later that such changes took full force.

There was also the realization that the management of quality of manufactured products required quality control of all functional areas of the organization. Edwards stated: "Another possibility is the establishment of the quality control as a functional part of top management...(good quality) results from the planned and interlocked activities of all the

organizational parts of the company...Expanded application of quality control has wide and deep social (and economic) implications" (Edwards, 1946, p. 18). Such interlocking activities were described by Juran in his description of the "quality atom" (Juran, 1951a), by Deming in his depiction of the production system (Deming, 1956), and by Feigenbaum in his Quality Control: Principles, Practice, and Administration (Feigenbaum, 1951), where a systemic view of the product life cycle was emphasized. With this began administrative applications of statistical quality control grew, first starting with personnel evaluation and time studies, cost control, and safety (Bicking, 1950), and later expanding into R&D and service applications.

Feigenbaum fine-tuned his ideas on organization-wide quality efforts into the concept of "Total Quality Control", or TQC: "The underlying principle of total quality control is that, to provide genuine effectiveness, true quality control management must start with the design of the product and end only when the product has been placed in the hands of the customer who has remained satisfied...(thus) quality is everybody's job in a business" (Feigenbaum, 1957, 1961).

It was in Japan however where local adaptations to the business environment were strongest, and where the seeds of the next paradigm were sewn most strongly. Decimated by World War II, Japan's industry had to be built from the ground up. With few precious resources to draw upon, Japan had to rely on its own industrial creativity to rise to a level of competitiveness in commerce. Japan had done little prior to World War II concerning the discipline of quality. In the 1940's several important organizations were formed: Japan Management Association (1942), Japan Standards Association (1945), and the Union of Japanese Scientists and Engineers (JUSE) (1946); all aided in the reconstruction of the country (Nonaka, 1995). Americans on-loan from Bell Laboratories introduced JUSE members to Shewhart's 1931 book and the Z.1, 2, and 3 quality control standards, and several members became intrigued by the concepts. In 1950 JUSE Managing Director Kenichi Koyanagi requested Deming, who had been in Japan several year previous to aid in census-taking, to deliver lectures concerning quality control methods (Walton, 1986). Deming's courses included "Training of Quality Control Engineers and Statisticians in Industry" and several lectures for top management (Kilian, 1988). It was here that Deming told them "...they could capture markets the world over within five years" and reminiscing "They beat that prediction. Within four years, buyers all over the world were screaming for Japanese products" (Walton, 1986, p. 14).

Deming donated the royalties from publication of his Japanese lectures back to JUSE,

where they were used to initiate the Deming Prize in 1951. The purpose of the Deming Prize is to recognize those companies that have successfully applied TQC, based on statistical quality control. The formalization of a criteria for excellence in quality systems, the proactive stance that JUSE took in supporting and promoting the Prize, and the influence of winning companies helped spread the concepts of TQC for decades to come.

Juran was subsequently invited to Japan in 1954, where he taught managers, engineers, and professors the organizational structures and functions for management of quality (Juran, 1954). The managerial focus that Juran taught was meshed with the practices of statistical quality control and other Japanese practices to form "Company-Wide Quality Control", or CWQC (Imai, 1986). By 1960 Japan had made significant in-roads into world markets. Koyanagi attributed the success to "excellent personality and high-spirited humanity of American teachers like Dr. Deming and Dr. Juran...depth and usefulness of Dr. Shewhart's philosophy and methods...(and) integration of quality control with management science and engineering technology (Koyanagi, 1964, p. 61).

Conversely Deming attributed the success of Japanese efforts in the 1950's and 1960's to several interdependent characteristics: (a) determination and confidence to become 'world class', (b) Japanese industrial experience and pride of workmanship, (c) understanding and commitment to Shewhart's concepts of statistical quality control (especially with respect to the notion of common and special causes, and the implications thereof), (d) proactive support by top management and government, (e) proper statistical education, and (f) open channels of communication (Deming, 1967).

The phenomena of "QC Circles", which began in Japan around 1962, should be considered an important step in the revolution towards a new paradigm of quality. The purpose of a QC Circle was to gather a small group of departmental workers together to spend time (usually off-hours) solving departmental quality problems. Juran attributes the initiation of the concept to the Japanese view of division of labor: "Japanese concepts of organizing work do not follow the strict Taylor concept of division of work, i.e. planning to be done by engineers, and execution to be done by foreman and workers. Instead, the Japanese leave a good deal of planning and creativity to be carried out by the production force. These same concepts of organizing work have carried over to the quality function" (Juran, 1967, p. 330). With massive training of workers in the methods of statistical quality control (Pareto analysis, cause and effect

diagrams, histograms, graphs, control charts, stratification, and binomial probability paper), support from management, and national promotion (the *Annual Foreman's QC Conference* and the JUSE journal *Quality Control for the Foreman* were started in 1962) the idea of QC circles took off, with 8000 registered circles by 1966 (Juran, 1967), and some 200,000 by 1984 (JUSE, 1985). QC circle membership was voluntary, and projects were typically selected locally. Interdepartmental quality problems were addressed by "Quality Teams", which typically consisted of workers, supervisors, and engineers, and had specific management direction.

It is interesting to compare the motivation aspects of the Japanese QC circle movement with other motivational programs at that time. First introduced in the 1930's, the "Scanlon Plan" for employee participation enjoyed popularity for several decades. The Scanlon Plan focused team attention on the "quality of work life", and issues involving quality, productivity, ergonomics, and safety were typically addressed (Feigenbaum, 1983). The Zero Defects Program (ZD), developed for the purpose of acheiving 'perfection' of quality, also had strong motivational components (Crosby, 1964; Halpin, 1966). ZD is based on setting of requirements, management support, and positive reinforcement. Behind ZD is the belief that people want to do their best, but supervisors don't necessarily create a vision for perfection; this new vision is created by "reconditioning the employee to take a personal interest in everything he does" (Halpin, 1966, p. 2). ZD is begun with a kick-off day, pamphlets that describe the program, and pledge cards that employees sign to signify their commitment to the program (Crosby, 1964).

Conversely Japanese QC circles took a very different approach to employee motivation. The QC circles were supported by formal training programs in statistical methods and problem solving; there was generally no pay for successful ideas; membership was voluntary and generally off-hours; and group efforts were emphasized over individual efforts. Juran attributes the leadership of Japanese managers, the security of life-time employment and associated benefits, and their differing view of organizational structures as the reasons why motivation for participation in QC circles was high (Juran, 1967). Others have also attributed the general humaritarian world view of the Japanese for the natural inclination towards continual improvement of quality (Pabst, 1972).

The power of QC circles and subsequent employee involvement, coupled with the Japanese concern with detailed planning, helped mature the concept of TQC into a new stage: Japanese TQC. At the heart of Japanese TQC is a customer-driven strategy. From such a

strategy three management functions emerge: daily management, cross-functional management, and hoshin planning. Daily management deals with those activities that revolve around the organization's processes. Employee involvement, QC circles, training, and suggestion programs are combined with the widespread use of the standard set of statistical quality control tools to yield small, incremental improvement, or Kaizen (Imai, 1986). Tracking of daily progress is made highly visible and is the focal point for all employees. Cross-functional management involves interactions between functional boundaries in the organization, such as design and manufacturing, and between the organization and its environment, i.e. customers and suppliers. Japanese TQC has placed great emphasis on the interactions which occur between boundaries, leading to such innovations as the Kanban system and just-in-time manufacturing (Monden, 1983), and quality function deployment (Akao, 1990). Hoshin planning, or management by policy, might be considered the Japanese counterpart to management by objectives. Goals of the organization are flowed down into specific policies so that there is overall coordination of the organization to its customers. The success of the Deming Prize in Japan lead to the general practice of operational (quality) audits, performed by the company president.

With the results of such audits strategic plans were readjusted and coordination held. Japanese TQC represents the third paradigm of the quality discipline, *total quality management*. It took a crisis in the West, however, for these concepts to be embraced widely throughtout the developed world.

The Paradigm of Total Quality Management

Because of the pervasiveness of *TQM* as a topic of discourse, I shall be relatively brief in my summary of the basic tenets of this paradigm. The reader is referred to works such as Anderson, Rungtusanatham, and Schroeder (1994), Dean and Bowen (1994), Deming (1986), Ernst & Young (1992), Hackman and Wageman (1995), and Spencer (1994).

A number of different environmental changes led to the widespread adoption of TQM principles, and the subsequent development of these principles into tools, techniques, and methodologies. The rise of consumerism, and thus higher quality requirements, began in the late 1960's and had a profound impact on the management of quality from the customer perspective (Juran, 1970). Global competition, brought about by both technical and political changes, made

competition all the more intense. This has furthered the choices available to the customer, and deeply sensitized organizations to their competitive challenges. Nowhere was this been more deeply felt than in the automotive business, where U.S. firms held the bulk of the U.S. market for decades only to see it erode to because of superior performance and quality by Japanese and German automobiles (Business Week, 1987). Professionals in quality have long advocated the importance of product excellence: "Superior product quality is the key to the continued economic health of the nation today" (Feigenbaum, 1966, p. 81). It took some time, however, to recognize the strategic importance of quality to firm success.

The Profit Impact of Marketing Strategies (PIMS) studies showed that higher quality products could have significant impact of profit and ROI (Buzzell and Heany, 1974). As Garvin shows (Garvin, 1988), many companies found (or re-found) competitive success when quality dimensions were brought into consideration during the strategic planning process. One striking example was Xerox, where Xerox's share of the U.S. copier market fell from 96 to 46 percent in the 1970's, due primarily to Japanese competitors. A new emphasis on benchmarking competitor performance, attending to customer satisfaction, and focus on new product development helped regain Xerox's status as an industry leader. In general, the new emphasis on strategic quality management placed new demands on the organization, in terms of market research, benchmarking, life-cycle costing, and measurement of customer satisfaction (Garvin, 1988).

In the 1980's and 1990's corporate leadership began to strongly espouse the important of quality. John Akers of IBM stated: "In today's fiercely competitive global business arena, quality is the bedrock requirement for survival" (Akers, 1991, p. 26). David Kearns of Xerox added: "As a nation we are just beginning to understand the power of quality as a competitive weapon. We are just beginning to fully realize that we are faced with a never-ending spiral of increased competition and heightened customer expectations" (Stratton, 1990a, p. 22).

An important event which crystallized quality as a organizational strategy was the inception of the Malcolm Baldrige National Quality Award (MBNQA) in the United States, and the subsequent development of national awards in Australia, France, Canada, Great Britain, and Mexico, to go along with the long-existing Deming Prize in Japan (Dooley, Bush, Anderson, and Rungtusanatham, 1990). Since 1988 the MBNQA has had several hundred corporate applicants. Tens of thousands of companies have requested the application guidelines, however, testifying to the use of the MBNQA in aligning corporate strategy and practice with the quality philosophy

(Main, 1990; Stratton 1990b).

Organizational quality practices also become the benchmark requirement for supplier certification, started by Ford with the Q101 program and made famous by Motorola's request that all suppliers make plans for pursuing the MBNQA. At a national level, the European Economic Community set forth organizational quality system standards which must be met in order for firms to access EEC's markets. As stated by Marquardt, et al. (1991, p. 25) "The ISO 9000 series embodies comprehensive quality management concepts and guidance...The ISO 9000 series was published in time to meet the growing need for international standardization in the quality arena and the wide adoption of third-party quality systems certification schemes."

The changes that took place in the practice of quality under the paradigm of *TQM* are too numerous to expand upon here; a summary of such changes follows:

- Quality moved from being the responsibility of the quality department to be the responsibility of everyone, in particular, management.
- Product quality shifted from being a product differentiator to being a necessity to compete at all.
- The importance of quality was extended beyond physical products, to include services and information; and extended its reach into new arenas such as health care, education, government, and religion.
- Issues of learning, training, education, and self-management (i.e. the human systems component of quality) came to the forefront of practice.
- Benchmarking and other methods of learning "best practices" flourished.
- Organizations established executive line authority (e.g. Vice President for Quality) for quality.
- Methods aimed at the continuous improvement of process quality were developed and widely disseminated and utilized. Improvement of process quality, whether through continuous improvement or reengineering, became a mainstream organizational activity.
- Organizations recognized the importance of focusing all of their activities on the customer and their requirements. Measures of customer satisfaction and retention became a key managerial metric for many organizations.

Some may point to the faddish-ness of the TQM movement, and downgrade the importance of

these developments. Part of the frustration with the "results" TQM has provided has to do with over-sold expectations, a hope for the "quick-fix", and with the natural phenomenon of rising aspirations (Dooley and Flor, 1998). There could be little doubt, however, that even without the moniker of "TQM", the principles, tenets, and assumptions of TQM have become deeply embedded in organizational practice and will remain a part of the organizational landscape.

The Future of Quality

If the existing paradigm of *TQM* continues, what types of developments in the field should we expect? On the other hand, if we are on the brink of a paradigm transition, can we identify "local adaptations" that may in fact be selected later? Several future scenarios are outlined.

A Kuhnian model of paradigm evolution would predict that if the current quality paradigm of *TQM* continues, then more context-specific theories and models will be developed that refine the more generalized existing knowledge base. We can already see this happening along a number of fronts, because it appears that the effectiveness of certain TQM activities may be dependent on the environment in which the organization finds itself in. For example, in a large scale study of over 500 companies (global), the International Quality Study (Ernst & Young, 1992) indicates that certain TQM practices may be more or less valid, depending on the maturity of the company. For low quality performers, a focus on teams, customer contact, empowerment, process simplification, design quality, and inspection worked best; for medium range performers, a focus on wide-scale process improvement, training, supplier involvement, metrics, design of new products, and a quality vision were best; and for high range performers, a focus on leadership, benchmarking, total employee involvement, strategic quality, innovation and product niching, and a highly visible quality vision worked best.

There is also some question as to whether TQM's focus on control is appropriate for environments where there is high uncertainty in roles, tasks, and organizational priorities (Sitkin, Sutcliffe, and Schroeder, 1994). In low uncertainty, "control is cybernetically valid", while in high uncertainty, "the only reasonable goal may be to do a good job of exploration and learning" (Green and Welsh, 1988, p. 554; March, 1991). Process improvement activities based on process metrics may actually be counterproductive (Dean and Bowen, 1994); in fact, companies are growing frustrated with the lack of success they have had in using metric-based

management to control and improve their new product development processes (Griffin, 1993). Fredrickson (1984) and others (e.g. Daft and Lengel, 1986; Lord and Maher, 1990) have found that comprehensive decision making--prototypical of TQM--was negatively related to performance in a highly unstable environment.

This proposition--that the holistic mechanisms of TQM, which tend to be rather mechanistic and deterministic in nature, may not be well-suited for environments where a high level of adaptability is required--is supported by recent developments in the field of complexity theory (Dooley, Johnson, and Bush, 1995). For example, Kauffman's work (1995) suggests that organizations are best optimized by optimizing semi-autonomous "patches", loosely coupled together. A patch represents a more local organizational entity, such as a work group or division. This strategy of distributed optimization stands in contrast to TQM's belief that an organization is best optimized by paying attention to the whole. Kauffman's work also suggests that the customer should be "listened to" most of the time, but not all of the time. Similar arguments from innovation scholars exist (e.g. Christensen, 1997).

Kauffman's model of evolution on rugged landscapes suggests that a process that has complex interactions between the variables associated with it cannot be easily optimized by trial-and-error learning (a hallmark ofof TQM); such an approach will almost certainly lead to getting "stuck" at a local rather than global optimum. In such rugged landscapes, experiments must be continuously performed, because not only are there multiple optima, but the landscape itself is constantly changing and shifting due to its coupling with other organizational landscapes.

Thus, one prediction is that *the models and theories associated with TQM will become more context-specific*; in management theory terms, this means a growing emphasis on contingency and configuration theories (Doty, Glick, and Huber, 1993).

As a discipline develops more context-specific theory, it also has the potential to dissipate away, into other, existing disciplinary structures. In many organizations today the quality department, and quality-related jobs within various parts of the organization have been eliminated. The reasoning is, if quality is everyone's job, why do we need a separate function to carry out these activities? It is possible that the concepts and practices of TQM will become so deeply embedded in ordinary organizational practice that the function itself will be essentially "dissipated". Thus, a logical prediction is *the quality discipline will die*.

Juran (1995) argues against this, noting that the notion of eliminating the quality

professional is just as absurd as the notion of eliminating accountants--one will always need quality specialists and experts, just as one will always need financial specialists and experts. This is especially true as companies begin to use more sophisticated statistical methods. A growing number of companies (Motorola, GE, DuPont), under the aegis of "six sigma", are training "brown belts" and "black belts"--statistical quality engineering experts. There have been calls for the profession itself to modernize, especially with respect to statistical methods; the pervasiveness and voluminous nature of measurement data in most modern manufacturing processes make many of the existing statistical methods of the field moot, and yet the discipline has been extremely slow in moving to computer-aided techniques and adopting more sophisticated statistical methods (Gunter, 1998).

Another way in which the quality discipline could evolve within the existing TQM paradigm is for *the quality discipline to broaden its scope and focus on the enterprise and/or the community*. One can examine trends in both academia and industry practice over the last century and note that efforts have successively focused on larger and larger scope. Scientific management focused primarily on issues at a task level, and 1930's efforts in work design and egronomics focused on issues at a job level. Individual areas (e.g. mechanical engineering, electrical engineering) continued to make progress on issues at a task and job level, while the field of industrial engineering (and others) focused on issues at a level of process. TQM and other recent efforts (e.g. world class manufacturing, organizational learning, benchmarking) have shifted the focus to issues at a level of the system.

The next obvious level of scope is that of the enterprise; an enterprise is defined as a collection of organizations whose goal is to coordinate themselves towards providing value to some end consumer (Choi and Dooley, 2000). One can already see this trend by the growing interest in enterprise requirements planning (ERP) and supply chain management. Examination of this century-long trend also highlights the fact that at each level, a focus on control emerges first, followed by a focus on issues of improvement. To-date, ERP and supply chain management efforts have focused almost solely on issues of control. We can predict therefore that in the near future, a growing number of efforts will be focused on improving the quality of the enterprise, and this may represent the next paradigm of the quality discipline, if the methods and theories that need to be used differ significantly from existing TQM theories and methods. Beyond the level of enterprise, we have a level of community; green manufacturing efforts and

ISO 14000 foreshadow this level of concern. It is not surprising to see so many quality professionals involved in the implementation of ISO 14000 environmental assurance programs; it may merely be a precursor of things to come.

A number of other changes and improvements to the practice of TQM are likely:

- Whenever an organizational task can be effectively automated, it eventually will be. Classical statistical process control (SPC) is an example where human intervention has been historically required because diagnosis and corrective action could not be effectively automated. The need for classical, human-centered SPC will diminish with advances in automation, feedback control, and automated diagnosis.
- The growing interest in "knowledge management" signifies an awareness that process knowledge, or know-how, matters. Knowledge management systems marshall the strength of information technology in order to share knowledge across space and time (Dooley, Skilton, and Anderson, 1998). Whatever knowledge resources can be made explicit and shared, however, can also be imitated. Since the ultimate value of the firm depends on knowledge that cannot be imitated, it is reasonable to assume that knowledge which is tacit and not easily imitated, as opposed to explicit, will grow in importance. For this reason we might expect that quality systems will increasingly focus on tacit knowledge.
- TQM's focus on the customer is only a half-truth; for the most part, organizations focus on segments or cliques of customers, not individual customers. The growth of "one-to-one" marketing, increasing flexibility in production and logistics, product postponement, and e-commerce all support the goals of mass customization--being able to serve the needs of individual customers. Quality systems will need to increasingly focus on the management of individual customer requirements.
- The constant improvement of quality in a particular market segment makes it increasingly difficult for a firm to create new value with its products. As firms get better at understanding what customers want and delivering it, this skill will not be differentiable--it will simply be required to remain in business. In order to enhance competitive stance, companies will focus on getting better at understanding the unarticulated needs of their customers, and develop solutions aimed at “total value creation”.

- There has been a wave of interest in applying quality concepts to "special" processes, such as new product development, supply chain management, and information systems. This is likely to be followed by a wave of interest in new process and service development.
- Quality efforts have tended to be most prevalent in industries where quality competition is fierce. Because of the intimate tie between their services and the constraint of geography, the areas of government and education have essentially been competitor-less. With a growing awareness that government services can often be done better by private firms, and with the dawning of distance-based and technology-enabled education, competition in government and education will likely force serious quality improvement efforts there.
- Increasingly the most important issue will not be quality leadership, product quality, process quality, or service quality... it will be information quality.

It is perhaps this last bullet item that deserves most attention in terms of how the discipline of quality might change in a more significant manner, i.e. shift to a new paradigm. We should expect that the quality discipline will evolve simultaneously with other changes in the world of business. In the past several years the Internet has brought on numerous changes in the nature of how business is conducted, and this will continue to be the trend. Currently however, e-commerce is still struggling with the basic quality issues such as delivery times and customer service, so it is unlikely that "the Internet Age" will immediately transform the discipline.

Over time though, the Internet may preclude such significant changes. A recent NSF-sponsored conference (http://nmm.eas.asu.edu/workshop/) on the topic of computer networks and quality highlighted this potential shift. In the age of telephones, the only part of the system that had to be considered relative to quality was the physical network itself; the telephones themselves were ubiquitous, uniform, and reliable. As communications developed on computer networks (as opposed to telephony networks) in the 1980's, designers and operators knew that they had to consider not only the physical network, but also the devices that were attached to the end of the network, e.g. the personal computers, and sometimes even the applications. For example, one scenario where quality might be comprimised is where one computer at one node in the network was incompatible with another, different computer at another node of the network (e.g. IBM PC's and Apple MacIntoshes).

With the advent of the Internet, things get even more complicated. In a local area network, all of the hardware (and protocol software) is compatible, and arranged into a single system. On the Internet though, the network is actually a compilation of networks, put together by vendors and providers that may in fact be competitive with one another. An e-mail sent on the Internet may traverse (in an unpredictable and unrepeatable patterns) dozens of different networks and servers, and each component of the system may or may not act in concert with the other components.

Additionally, attention to quality of service on the Internet must also include the user: the total quality package includes the physical network, the devices attached to nodes of the networks, and the customers using the information/computing devices (Baumann, Bhattacharya, Capone, Dooley, Fritsch, and Palangala, 1999). On the Internet, a user is essentially free to behave in any number of different ways, without signalling or identifying what their exact needs are. How can we ensure quality of service on the Internet when in fact we don't know, any may never know, the exact requirements of each customer?

The Internet provides other basic challenges with respect to quality. With "no one in charge", who is responsible for quality? How can quality be ensured, end-to-end, when in fact the elements of the system are not put in place in a purposeful, cooperative manner? Who is supposed to provide "quality leadership" to the Internet? How can the quality of information be assured when its source is potentially of unknown origin? How can the Internet and other information systems guard themselves against security breaches and purposeful acts of harms while maintaining ease of use for its honest users?

The issue of Internet quality of service is an example of other changes that are likely to take place in the business world in general. As supply and distribution chains fractionate and become ever more complex, the business world looks less like an organized heirarchy and more like a complex adaptive system (Dooley, Johnson, and Bush, 1995; Choi and Dooley, 2000), and our TQM paradigms based on predictability, control and linearity may be insufficient--we simply may not be able to address all of these challenges by improving the existing paradigm of TQM. To that effect, one may look at how issues of Internet quality are dealt with, as a precursor to a possible new paradigm for the quality discipline.

Conclusion

I have put forth the proposition that the discipline of quality can be thought of as evolving over time through three paradigms: caveat emptor, quality control, and total quality management. Elements of each paradigm can be identified, post-hoc, as being present within the previous paradigm, in some local manner. This leads naturally to the question of: what's next? Within the existing paradigm of TQM, theories and models are likely to become more domain-specific, and improvements will be made to existing methods and approaches. The issue of quality of service on the Internet may foreshadow a change in the existing TQM paradigm, to perhaps something best described as "distributed and emergent TQM".

The model put forth in this paper is based on narrative. While the case study put together may be convincing, it is hardly a test of hypothesis as the narrative is by design opportunistic in what is included and what is not. A more rigorous test of the hypotheses put forth here is in order, with the most likely and useful method for doing so being content analysis of historical (textual) data. The next step in this research program will be to examine the contents of *Industrial Quality Control/Quality Progress*, the discipline's hallmark trade journal, over a period of fifty-plus years, using sophisticated content analysis methods to indentify the epochs of time so-claimed to represent a particular paradigm of thought and practice (and therefore language).

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