A Panoramic Review and Vision on "Integration" for Quality Management

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Abstract

The issues of "Integration" in quality management and related fields have been discussed for a few years. Literature review reveals that this is a large and multi-disciplinary topic. Although there are many publications on this issue, very few well-cited articles show direct illustration to why, what and how to implement the "Integration" strategy in quality management. This paper presents a panoramic review and vision on "Integration" issues of quality management, in the perspectives of concept, scope, organization, information, process, and culture.

Key words: quality management, integration, organization, information, process, culture

1. Introduction

A lot of researches and practices have been focused in "Integration" quality management field in the past decade. There are two major components in promoting its evolvement. The first one is the development of technology, from which the requirements and feasibility of integration generate. Since the launch of CMI (Computer Integrated Manufacturing) in 1970s, the "Integration" has been widely conceived to be an effective approach to improve the performance of a manufacturing system, including its quality system. The second one is the progress of managerial philosophy, which leads people pursuing more efficient management manners. Several quality gurus such as Deming, Juran, Feigenbaum, etc. had set foot in this topic. The ideas of organization integration, culture integration, system integration, etc. were addressed in their works on TQM, although some of them did not directly use the term of "Integration" [1-3].

The "Integration" is still evolving. Some recent technological and social changes are influencing it more drastically than ever

before. For instances, Globalization is becoming a trend of manufacturing; Agile Manufacturing (AM) and Virtual Enterprise (VE) break the traditional enterprise border; Internet is dramatically affecting the way products are made, bought and distributed; Supply Chain Management (SCM) is extending manager's eyeshot from their own business to a more broad scope. All these are pushing the demand for integrated quality management.

Literature review reveals that "Integration" is a large and multi-disciplinary topic in quality management. Nearly all factors in an enterprise such as equipment, human, organization, information, culture, etc., as well as all systems including CAD/CAM/CAPP, MRPII, ERP, CRM, etc., are involved. Yet, as far as we know, even though a number of publications use the term of "Integration" in their discussions and stress the necessity of integration for quality, most of them merely concern on given aspects, none of them shows a panoramic and systematic illustration to why, what and how to implement integration in quality management.

This paper intends to fill up this gap and presents a panoramic review on the "Integration" strategies, approaches and practices in quality management (Section 2-6), and introduces the new development and tendency of integration (Section 7). Finally, a panoramic model will be summarized as a conclusion.

2. Definition

In the Oxford dictionary, "Integration" is generally defined as "the marking up or composition of a whole by adding together or combining the separate parts or elements, combination into an integrating whole" [4].

Yet, this general definition is specialized in different fields. A recent study of Wilinson and Dale [5] showed that integration was being carried out in a number of different ways and indicated differences in understanding of what the term meant and its applications.

Even in the particular field such as quality management, the understanding of "Integration" is also diverse. A broad review of practices and researches in this field reveals the existence of three typical views to integrated quality management, or integrated quality system, respectively labeled as the technical view, managerial view and total view.

Technical view

In the technical view, "Integration" is defined and studied from the aspects of information and factory automation technology. Dooley et al. defined integration as "the sharing of data of information among subsystems and systems" [6]. With such assumption, the Integration Quality System (IQS) is usually regarded as a practical system that is typically comprised of computers, software, numerical inspection

equipments, tools, and so on.

Hierarchically, the IQS is implemented at work cell level, shop floor level, enterprise level or even inter-enterprises level. Functionally, IQS is known to include integrated quality information system, integrated quality control system, integrated quality planning system, integrated quality document system, etc.

Some researchers treated IQS as a subsystem of CIMS (Computer Integrated Manufacturing System). Chang recognized the IQS as computer-integrated quality information system [7]; while Zhou [8] and Duan [9] defined the IQS as a computer aided quality management which included a series of functions such as statistical process control, quality planning, quality improvement, etc. Other researchers [3,6,11-13] hammered at the integration among the numerical design system (CAD/CAM/CAPP), machines (Computer Numerical Control Machine, CNC), inspection equipments (Coordinate Measuring Machines, CMM) and other manufacturing resources. A typical example is an integrated process control model defined by Feigenbaum [3], in which the manufacturing equipments, inspection equipments and CAD system were integrated on the basis of a central database. Furthermore, Reimann et al. developed a practical architecture for integrated automated quality control [13], which could integrate inspection systems with automated manufacturing systems.

Efforts were also made to the integration of methodologies and tools. Combining the existing quality management techniques into an integrated framework is emphasized by several quality gurus and researchers [6,14-16] Among them, Dooley defined integrated quality system as a framework within which the concepts of process control can be used coordinately and as a whole to improve quality and productivity [6]. By this way, the quality related information obtained at different hierarchical levels of the manufacturing process is used in an integrated nature to improve overall process quality.

Managerial view

While the integration concept steadily grows along the technical axis due to the progress of advanced manufacturing and information technologies, some researchers make their studies along the managerial axis, where the IQS is regarded as a managerial system. The discussions usually center on the managerial factors such as organization, human, culture, society, managerial methodology and philosophy, and so on.

Castle [17] defined an IQS as an integrating model for managerial use, which unifies existing approaches and helps managers navigate through the maze by presenting them with an integrating map and as a management system. The management system, by using intelligent activity and developing policies, encourages the evolution

of integrated, motivated, and learning human activity in seeking continuous improvement. It aims to be consistently distinctive in the quality characteristics (tangible and intangible) the firms provide, at their price, for the greater benefit of their customers, in comparison to competitive offerings.

Wilkinson and Dale studied the integration from the perspective of standards and systems. They thought that dealing with separate management standards and systems, such as ISO9001, ISO14001 and BS8800, and ensuring their alignment with the organizations' strategy have been proved difficult [5,18]. They advocated that the need for an IMS (integrated management system) has arisen as a result of the decisions of organizations to implement an environmental management system and/or an occupational health and safety management system in addition to a traditional quality management system.

Bititci et al focused on the integration of performance measurement systems [19]. Their survey showed that the measurement systems currently in place, including both the financial, non-financial and quality-oriented measurement systems, were still being used in a manner which did not promote integration, so as to the company's strategy, improvement projects and performance measures were always in conflict. Therefore, an integrated set of performance measures that supports rather than contradicts business objectives is clearly required.

Chan et al [20] presented a case study of the Hong Kong Mass Transit Railway Corporation that the integrated quality system should be sufficiently flexible to integrate the requirements of various management systems, including quality, safety and environment management systems.

Besides the above examples, some other studies were also conducted from aspects of: organization integration [21-23], culture integration [24-26], process integration [27-31], information integration [32-34], methodology integration/integration methodology [7,10,17, 35], etc. Some of them will be discussed in details in the following sections.

Total view

A viewpoint from the "total" perspective defines IQS as a total solution, of which the managerial and technical efforts are two integral and interdependent fundamental components in helping organizations to achieve the quality objectives.

Feigenbaum [3] has defined the fundamental factors affecting quality as the "9 Ms", including both managerial and technical factors, namely: markets, money, management, men, motivation, materials, machines and mechanization, modern information methods, and mounting product requirements. With so many factors involved in the managing of quality, Feigenbaum also opined that it is essential for a company and a plant has a clear and well-structured system which

identifies, documents, coordinates, and maintains all the key activities needed to assure the necessary quality actions throughout all relevant company and plant operations. A company will lose their competition without such systematic integration. On the basis of this thinking, he further defined the Total Quality System (could be considered as an IQS in our opinion) as the followings:

A total quality system, (or IQS) is the agreed company-wide and plant-wide operating work structure, documented in effective, integrated technical and managerial procedures, for guiding the coordinated actions of the work force, machines, and information of the company and plant in the best and most practical ways to assure customer quality satisfaction and economical costs of quality [3].

Similarly, Dessouly et al also presented a total definition to the IQS [10]. Yet, he defined from the aspects of process integration and resources integration. According to Dessouly, an IQS is a coordinated set of resources and processes to ensure that the system as a whole achieves its quality objectives, in concert with other objectives such as productivity and profitability. This definition has an assumption that integration is effected along two dimensions. One is process-wise, through consideration of the quality characteristics in all stages in the life cycle of the product. The other is resource-wise, through accounting for the impact on quality characteristics of human resources including employee motivation and organization structure, as well as facility resources and information resources.

To give a panoramic scenic of integration in quality management, the conventional border between technical and managerial has to be broken. In this paper, from a panoramic viewpoint, we redefine four dimensions of integration as organization integration, culture integration, process integration, and information integration, and provide a detailed review on them in the following sections.

3. Organization integration

Reasons of organization integration

The traditional organization structure is typically hierarchical (so called pyramidal) and functional, with the following features:

- Function-centered departmental division with which each part of the organization is only a single-function entity and there is a clearly function borderline between the different divisions;
- Multi-layer hierarchical structure and vertically "up-or-down" administration pattern rather than horizontally across functions.

Functional structures provide a clear chain of command and allow people to specialize

in the aspect of the work for which they are best suited. They also make it easy to evaluate people based on a narrow but clear set of job responsibilities [36]. For these reasons, they are commonly adopted in many organizations. Juran et al [37] has illustrated the quality organization in the USA in 1960s and 1970s as "Each functional department in the company carried out its assigned function and then handed off the result to the next function in the sequence. This was often called throwing it over the wall. At the end of the sequence the quality department separated the good products from the bad."

Obviously, such an organization structure is not "integrated" that the functions, processes, information and staffs are separated by the hierarchical layers and divisions. Juran had fiercely criticized such organization state and listed six deficiencies of it [37]. Many other researchers also criticized this organization mode. At the 9th point of his famous fourteen points, Deming argued that "Break down barriers between departments. Encourage research, design, sales and production to work together to ..... and use" [1]. Evans et al have systemically summarized the problems with the functional structure in three aspects [36]. Firstly, the functional structure separates employees from customers. Few employees in the functional organization have direct contacts with customers or even a clear idea of how their work combines with the work of others to satisfy customers. Secondly, the functional structure inhibits process improvement. No organizational unit has control over a whole process, although most processes involve a large number of functions. This is because the break up of the organization into functions is usually unrelated to the processes used to deliver a product to the customer. Thirdly, functional organization often separates the quality function from the rest of the organization, providing people with an excuse for not worrying about quality. Furthermore, it breaks the feedback loop that informs employees that their work needs to be improved. A conclusion can be made from the above discussions that lack of integration is the main shortage of the functional structure.

Hackman et al. argued that one assumption of TQM is that organizations are systems of highly interdependent parts, and the central problems they face invariably crossing traditional functional lines [22]. To produce high-quality products efficiently, for example, product designers must address manufacturing challenges and trade-offs as part of the design process. Many efforts have been made to improve the integration of the organization. Among them, cross-functional team and reduction of functional hierarchies are the two main approaches.

Cross-functional quality team

Cross-functional team (or teamwork) is an important branch of organizational behavior and organization management, which has been introduced into the quality management field to improve the performance and integration of quality systems.

A team is more than just a group of people working together for something [38-41]. Spiegel et al. has given a discriminate between "group" and "team" [40]. According to him, a group is a number of individuals who are together because of common characteristics or interests; while a team is a group of individuals who work together, who have the same objectives, and whose work is mutually dependent. Though there is no standard definition, many literatures define this term in a similar way. For instances, Parker defined team as a group of people with a high degree of interdependence geared toward the achievement of a goal on completion of a task [38]. Salas et al. [42] defined a team as a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/ mission, who have each been assigned specific roles or functions to perform, and who have a limited life span of membership. Aune's definition is "a team consists of two or more persons engaged in social interaction, having a stable and structured relationship with each other, mutually depending on each other, sharing common goals and understanding that they are members of the team" [21]. Unlike these embodiment defined, Deligonul gives a definition from the collaborative aspect that teams are formal collaborative work arrangements made up of a relatively small number of members who unite with their complementary expertise for an exclusive assignment in addition to their concurrent assignments elsewhere [23].

A common point of the above mentioned is that they all emphasize the integration and collaboration as critical to a successful team and the cross-functional quality team is conceived to be an important form of integrated organizations. In fact, quality team is always one important basic approach of TQM from the beginning. Cross-functional team is one of the most commonly prescribed interventions by TQM gurus such as Deming, Juran and Ishikawa. Deming recommended that everyone needed to participate as a team to improve the input and output of each stage [1].

Evans et al studied the team-based organization from the perspective of process integration, and introduced several practice cases of different team-based structures [36]. Cross-function gradually becomes the main feature of these team-based organization structures. In fact, it is the responsiveness and flexibility requirements of the rapidly changing marketplace that have been raising the popularity of cross-functional teams in

the corporate world [23].

Depending on the size of the organization and the nature of the processes, cross-functional teams may include everyone who contributes to a given process or only a representative subset. The teamwork style is diverse in different organization environment. Aune has classified the typical team styles in TQM as steering teams, management teams and task-oriented teams [21].

Reduced hierarchy

"Flatter Organization structure" is a popular topic in recent years in organization theory fields [36,43]. A flatter organization structure is usually realized through the integration of those tasks into upper- or lower-level responsibilities [43]. In flatter organizations, several levels of middle management are often eliminated that, in turn, improves communication between top managers and frontline employees [36]

For this reason, going with the cross-functional team, reduction in the number of hierarchical layers of organization is also conceived as a useful approach to improve the organizational integration of a quality system [36,44,45].

4. Information integration

The need for information integration

Quality information is an important resource to modern manufacturing organization. Facing the competitive global market and more complex manufacturing environment, efficient and accurate information processing means more to quality management. Ross et al pointed out that the accurate and timely information permits purposeful planning and decision-making, and drives quality and technological resources [46]. Similarly, Chang et al argued that implementing the TQC (total quality control) philosophy in a manufacturing organization will involve the management, analysis, interface and coordination of information for all phases of the manufacturing cycle, in which information integration is vital to continuous quality improvements in the TQC environment [7].

Rzeznik gave a vivid evidence to show the benefits of quality information integration [33]. In his example, owning to the timely communication and quality data sharing between shop floor operators and manufacturing engineer through Internet, inferior products are prevented from being built, company money is saved, and production loss is limited. Similarly, Vann [47], Goyal [48], Gunasekaran [49], Chase [32] and Tsung [34] also proved the necessity of quality information integration in process quality control and improvement.

Scope of quality information integration

The scope of quality information

integration can be understood from both horizontal and vertical directions. Along the manufacturing cycle, Chang et al classified the quality information integration as three phases, pre-production, production and post-production [7].

The amount of data associated with pre-production phase is enormous. It is a formidable but necessary task to organize, classify and correlate these data generated and utilized by marketing, customers, research, engineering, purchasing and quality control. In this phase, quality information system manages, coordinates and analyzes data on: market research, customer requirements, product design evaluation, purchased parts quality, process capability and variability, quality control plan, production operation plan, and incoming inspection, etc.

In the production phase, the quality information system should be inclined to process control. The quality information system should function in concert with manufacturing resource planning system, tool and equipment control system, and engineering design system. In this phase, the quality information system manages, coordinates and analyzes data of in-process inspection, statistical process control, shop floor reject analysis, final inspection, equipment maintenance, process and manufacturing procedures, results of audits, etc.

In the post-production phase, the information obtained from various customers regarding a company's products can be of high strategic value. The quality information system should include comprehensive data feedback mechanisms, standardized data acquisition formats, and sufficient data manipulation capability. In this phase, quality information system manages, coordinates and analyzes data of packaging, shipping, warehousing, after-sale service, customer complaints and claims, product performance, field maintenance and repairs, and product warranties.

Vann et al. gave a hierarchical description on quality information integration [47]. A four-level computer integrated quality information system for a manufacturing plant was introduced. The first level composed of sensors through with the accurate and reliable quality information was obtained. At the second level, the user acquires the data with a high-speed microcomputer-based system, and displays the results to the operator or process engineer in easily understood formats. Real-time monitoring and in-process SPC (statistical process control) functions provided by this level could enhance the shop floor quality control ability. The third level provides funneling all information from all machines on the floor to a host, supervisory workstation computer. Multiple monitors at different locations throughout the plant can also receive this information and perform different but concurrent tasks, including shot profile

monitoring, detailed off-line analysis, SPC analysis from all machines, examining production status of all machines, generating reports on production, scarp, and downtime, and calculating setup parameters. At the fourth level, plant operations information is funneled into a plant-wide or company-wide computer system, permitting data archiving, further analysis, and report generation. This information then can be integrated with other data processing functions such as payroll, scheduling, and production analysis.

Considering the data needed and handled by the quality information system, there is only few data specifically generated for the quality management functions. Most of the data are generated for manufacturing planning and control systems [7,9,50]. Thus, it is advantageous to include quality information system within the enterprise information system framework and view quality information as one of the integral part of enterprise information set.

Approach of quality information integration

Computer integrated quality information system is widely conceived as an effective approach for quality information integration [3,7] Juran et al. defined quality information system as an organized method of collecting, storing, analyzing and reporting information on quality to assist decision makers at all levels [37]. The investigation of Chang et al [7] revealed that although many companies have implemented computer-based quality information systems at certain extent, most of these systems were standalone systems and limited to solving specific quality problems, such as quality inspections, statistical process control, vendor quality monitoring, etc. As a result, various quality information systems are a series of "island of information". Taking advantages of the state-of-the-art information technologies, a closed-loop computer integrated quality information system can be accomplished within the framework of enterprises application system and integrate various quality functions of an organization, namely; market planning, quality standards, outsourcing, measurement and testing, on-line inspection, statistical process control, field service, failure analysis, and customer feedback, etc. [7,9,50]

Besides computer integrated quality information system, efforts are also made from other aspects. Typically, in a managerial standpoint, Rose et al discussed the integration from the aspect of knowledge creation and sharing [51]. She criticized that there has been somewhat a disconnection between the activities aimed at facilitating quality improvement.

5. Process integration

A "process" is a structured measured set of activities designed to produce a specified output for a particular customer or market

[52]. From a viewpoint of value chain, it can also be defined as "a means whereby value is added to inputs so as to provide a more valuable output" [53].

Many companies have adopted a process orientated view of their operations, replacing the traditional functional viewpoint [30], with a view towards gaining benefits by better integration of operations [31], and identified Integrated Process Management as a key element of its approach to TQM [27,28]. From the viewpoint of quality, process integration can be classified into two layers, the narrow-sense and the broad-sense ones.

Narrow-sense-production process integration in shop floor level

An underlying idea of TQM is to achieve quality at sources, pointing to the need to monitor the product at all processing stages [53]. It is argued that an approach to integrate inspection systems with automated manufacturing systems is important to complete the computer-integrated manufacturing loop. In an integrated shop-floor framework, the inspection process runs simultaneously with manufacturing processes that the inspection results could be used immediately to correct or adjust the manufacturing processes.

Inspection was always isolated as "off-line" or "post-process" inspections but integrating the shop-floor inspection process with the manufacturing processes has become a research hotspot in factory automation since late 1980s [54]. Integrating the inspection system with CAD/CAM system by an automated programming system which could generate inspection process planning from the result of CAD/CAM system are widely conceived to be important to complete the computer integrated manufacturing loop [6,10-12,53,74]. Many attempts have also been made on CAIP (computer aided inspection planning).

Broad-sense - enterprise business process integration in whole product lifecycle

The shop floor quality control is far from being the whole product lifecycle oriented quality management, which nearly covers all the enterprises business processes. The ISO9000 has clearly defined the quality management process as a closed loop across the whole product lifecycle from market to the after-use disposal. A lifecycle oriented Integrated Process Management (IPM) is necessary to quality management [27,29-31]. IPM is able to break down the barriers between the departments via a common language and common format, so as to integrate the departmental "islands" into a whole process [27].

The implementation of IPM is far beyond a single technical or managerial issue, but a complex enterprise reengineering project. Many efforts have been made from the aspects such as BPR (Business Process Reengineering) [55,56]; CE (Concurrent

Engineering) [57,58]; IPPD (Integrated Product and process development) [49,59]; QFD (Quality Function Deployment) [27,49,60], etc.

6. Culture Integration

Organization culture has great impacts on the quality management. Evidence is reported to show that successful TQM implementation is dependent on quality being embedded in and reflected by the culture of the organization [24,25]. In global manufacturing and supply chain environment, the impact of culture factors is more prominent than ever before. To realize effective integration of quality management between the companies with different cultural backgrounds, the issues of cultural conflict and confluence are unavoidable.

Garvin labeled four major quality cultures as "inspection culture", "statistical control culture", "quality assurance culture" and "strategic quality management culture" [61]. Cameron and Quinn explicitly defined quality culture as "a subset of an organization's overall culture, which reflects the general approach, values and orientation toward quality that permeate organizational actions" [24]. By a six-year interview survey with senior executives in more than 100 manufacturing and service organizations, they prove the existence of different quality cultures, and provide a framework to classify them into: "Absence of a Quality Emphasis", "Error Detection Culture", "Error Prevention Culture" and "Creative Quality Culture". Lamprecht has discussed some issues about culture compatibility in implementing global quality system and raised four types of cultures, namely, "family", "Eiffel tower", "guided missile" and "incubator", with their impact to the ISO 9000 implementation result [26]. It can be concluded from the above-mentioned that, in global quality management, cultural barriers are something must be concerned and conquered but never could be thoroughly eliminated.

Yet, we find, although many literature exist in the topics of organizational culture and quality culture, the comprehensive studies on quality culture integration and confluence are still lacking.

7. Vision of integration

Fighting the more fiercely global competition forces manufacturing companies to higher levels of quality, productivity, and performance excellence, the need for information systems, new technologies, and new philosophies has grown proportionately [46,62]. In such circumstance, along with the flourish of new concepts such as SCM (Supply Chain Management), AM (Agile Manufacturing), VE (Virtual Enterprise) and E-Commerce, etc., the researches and

practices of integrated quality management indicate the following new features and hotspot.

Globalization

In recent years, the trend of globalization has been imposing great impact on manufacturing organizations. According to Allen [63], globalization means being able to serve the customers and their requirements wherever needed and means having the design, manufacturing, and marketing resources located near the customer in countries around the world. Globalization entails more than international trade or being a multinational company. It has to do with designing, manufacturing, and marketing a product right there in a particular locale for a specific market niche. This brings new challenges to quality management. The organizations have to face a multinational, multi-culture, and global distributed management environment. Accordingly, the scale of integration, including organization integration, information integration, and process integration, is extending from single enterprise and local region to multi enterprise and global region. There is a strong demand for globalization oriented approaches and technologies of quality integration. Yet, the progress of studies seems far lag behind the increasing demand, few publications directly refer to this issue.

Multi-organization

Facing the global manufacturing environment, people now find that it is no longer enough to manage their own organizations. They must also be involved in the management of the network of all upstream firms that provide inputs (directly or indirectly), as well as the network of downstream firms responsible for delivery and after-market service of the product to the end customer, which is so called SCM (Supply Chain Management) [64]. According to Handfield et al, SCM is the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage.

Unlike the traditional approaches, the SCM emphasizes the involvement of suppliers to improve quality and meet customer specifications [65]. Long-term partnership development with suppliers is advised to gain product improvement [66-70]. An integration of quality management based on partner relationship is thus required. However, developing such integration has proved to be challenging [65,71]. Barriers may be encountered on both managerial issues and technical issues; for example, the change in belief and a shift from the traditional adversarial buyer-seller relationship to co-makership [65,72,73]. The development of a supply chain oriented quality information system, which is typically an inter-organizational information system, is much more complex

than single-organizational one [64].

The research on SCM oriented quality management integration is becoming a hot topic. Wong et al [65] examined the contribution of the trust, long-term partner relationships with suppliers to quality improvement. Kanagal [66] introduced an effort named Partnering for Total Quality that championed by the USA government-industry consortium on semiconductor manufacturing technology, and gave a step-by-step roadmap of implementing partnering for total quality. As for the partner assessment and selection, which is an essential issue in partner relationship, American Society For Quality (ASQ) provided a series of reference approaches [69,70]; John Schuler introduced an approach named Standardized Supplier Quality Assessment in 1995, which is based the on ISO9000 and Malcolm Baldrige National Quality Award criteria [67]; and Franceschini and Rafele presented an indicators set for partner quality evaluation [68].

Internet based

The rapid development of information technology and Internet is dramatically changing the way of people' life, as well as the manner of business process and enterprise operations. Large amount of organizational and individual activities are running through Internet. E-Commerce, B2B (Business to Business) and B2C (Business to Customer) become popular terms. Accordingly, there has been an obviously trend of transforming the integrated quality system, particularly the integrated quality information system, onto the Internet platform, so as to better supporting the globalized and distributed environment. Certain efforts have been made. Nancy Chase has introduced a web-based software named WebSPC, which allows people in different locations to share the statistical-process-control (SPC) data on the internet/intranet. Another software with similar applications is Quality Analyst Web Server software, from Northwest Analytical Inc. This product is just what its name implies: a package that includes Web-server capabilities in addition to all the attributes of the company's statistical-quality-control (SQC) software. This software is designed to run on intranet/extranet/internet and people can view the data using a simple browser from all over the world [32].

8. Conclusion: a panoramic framework of quality integration

On the basis of the above discussions, a panoramic framework of quality integration is presented as figure 1. In the framework, the organization, information, process and culture are identified as four basic elements of the integrated quality management. Although they are discussed respectively in the above sections, they should not be looked as separated ones. In fact, it is

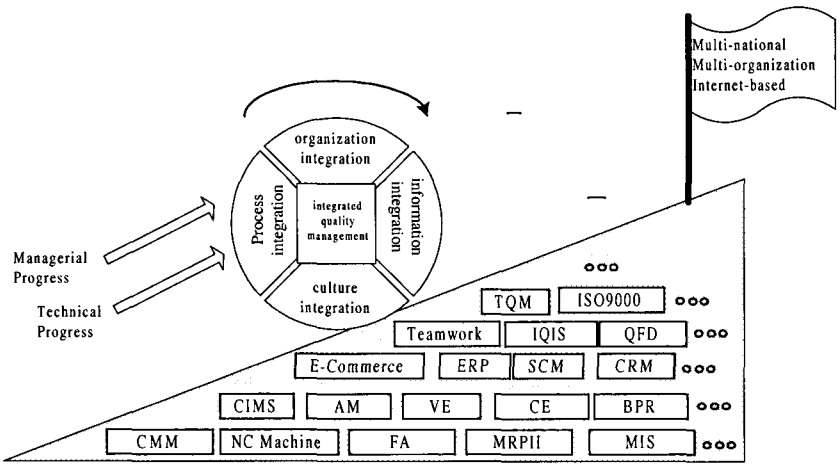

Figure. 1 A Panoramic Framework of Integrated Quality Management

impossible to give a clear boundary between them, neither in a philosophical meaning nor in a methodological manner. In philosophy, they all emphasize and pursue the breaking down of existing barriers in quality management. As for methodological approach, they are the integral and interdependent parts of the integrated quality management. Cross-functional teams and flatter organization structure provide the primary organizational mechanism for information and process integration programs. Information integration is the basic precondition for the efficiently operation of integrated organization and process. Process integration, in turn, is able to dramatically improve the organization performance and streamline the information flow. Culture integration always has great influence on the overall integration.

Two forces have been greatly promoting the evolvement of integration concept in quality management, namely; the development of managerial philosophy and advancement of technology. Integrated quality management is of a multi-disciplinary nature. Its development is always affected by the evolvement in related fields; such as the development of CIMS, TQM, CE, QFD, organizational theory, etc.

Facing the fierce global competition and the rapid progress of information technology, the integrated quality management will develop along the directions toward globalized, multi-organizational and Internet-based. Yet, more efforts have to be made for climbing such hill.

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