An Examination of Quality Concepts and Their Value: Developing a Better Convergence between Quality Management and Systems Thinking in the U.S. Shipbuilding

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The era of globalization and the, evolution of technology and society have created a progressively increasing imbalance between the socio-cultural and technical aspects in organizations. We present here a theoretical construct to examine how these world processes have affected the perception and pursuit of quality and value in the non-commercial sector of the U.S. Shipbuilding industry. Many of the uncertainties with which we deal in the measurement and management of quality are traceable to a lack of understanding the links between quality and value. Convergence of quality thinking and systems thinking with emphasis on the value generation process in the system perspective are addressed.

KEY WORDS: Globalization, Paradigm, Quality Management, Self-organization, Systems Thinking, U.S. Shipbuilding Industry, Value

INTRODUCTION

The fact that a non-commercial sector of the U.S. shipbuilding industry produces vessels that are complex, multidisciplinary, one-off products (Andrews, 1998) makes it a permanent source for examination and/or modification of quality concept architecture and for recommendations for quality management in the adjacent industries. It offers effective knowledge and high quality vessels based on its quality concept architecture that supports advanced production technologies, good quality management and process control, which help it to apply its knowledge in the production of its products. U.S. non-commercial shipbuilders created and maintain an image of high value quality in the products they produce.

However, shortages of skilled, trained employees, particularly in areas such as the Gulf Coast, call for re-examination of quality concepts and to integrate systems thinking into quality management for better understanding of the integrated actions of recruiting, educating, and training of entry level and job-changing workers and professional development and retention of current employees (NSRP, 2010).

Through this quality re-examination and systems thinking integration approach, the industry has an opportunity "to get rid of the old tea" as Pirsig points out in his analogy (1991, p.25):
"There's an old analogy to a cup of tea. If you want to drink new tea you have to get rid of the old tea that's in your cup, otherwise your cup just overflows and you get a wet mess. Your head is like cup. It has a limited capacity and if you want to learn something about the world you should keep your head empty in order to learn it. It is very easy to spend your whole life swishing old tea around in your cup thinking it's great stuff because you were so sure the old stuff was so good, because you never really tried anything new…on and on in an endless circular pattern."

A systems thinking framework involves cognitive mapping and system dynamics modeling to analyze the industry quality concept architecture and conducting case study research for value creation analysis. The combined new approach can illuminate how a business or industry can maintain its competitive advantage in the long-run.

This new theoretical construct attempts to provide a detailed analysis of the quality concept architecture in the shipbuilding industry stressing the competitive advantage strategy of the non-commercial sector of the US shipbuilding industry through integration of quality management with systems thinking through value.

A SHORT REVIEW OF THE RELEVANT LITERATURE

This literature review provides an overview of the three core elements of interest in this research: Quality, Systems Thinking, and Shipbuilding.
The structure of this review is presented in Figure 1

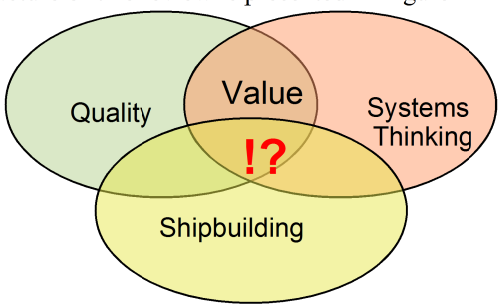

Figure 1. Literature Review Core Elements

What is Quality: Definitions of Quality & People in Quality

Quality has been defined in a variety of ways, and some of the definitions are presented in Table 1 below. There are many different definitions for quality because quality is an abstract idea, and only with the introduction of "value" does it become definable.

A "mechanistic" view of an organization, a view that ignores critical sociocultural aspects affecting the business organization and operations, is insufficient for a holistic view of the identification of organizational tools to originate quality concepts and to achieve quality goals.

Table 1. Definitions of Quality (Flood, 1993, p.42; Beckford, 2010; Pirsig 1984, p.200)

#	Name	Definition
1	Deming	Quality is a predictable degree of uniformity and dependability, at low cost and suited to the market
2	Juran	Quality is fitness for use
3	Crosby	Quality is conformance to requirements
4	Taguchi	Quality is the (minimum) loss imparted by the product to society from the time the product is shipped
5	Feigenbaum	Quality is in its essence a way of managing the organization
6	Hoshin	Quality is correcting and preventing loss, not living with loss
7	British Standard Definition	Quality is the totality of features and characteristics of a product, service or process, which bear on its ability to satisfy a given need; from the customer's viewpoint
8	Flood	Quality means meeting customers' (agreed) requirements, formal and informal, at lowest cost, first time every time
9	Geneen, cited by Crosby	Quality is not only right, it is free. And it is not only free, it is the most profitable product we have
10	Logothetis	Quality is simply a way of managing a business organization
11	Persig	"A real understanding of Quality captures the System, tames it, and puts it to work for one's own personal use, while leaving one completely free to fulfill his inner destiny"

The underdeveloped understanding of quality's multi-functionality in conjunction with category of "value" results in perceiving quality within a narrow concept of an amalgamation of isolated process elements, as in welding, documentation, etc. Quality strategy developed by management often is limited to the historical aspects of production activities. This strategy often generates conflicts when attempting to integrate advanced technologies while simultaneously attempting to adhere to the existing strategy of quality. New technologies demand implementation of new theoretic foundations for quality concepts. A "mechanistic" view of an organization by management, a view that does not consider new theoretical foundations for new quality concepts, limits the affective integration of advanced technology, risking the quality, value, and competitiveness of the organization output..

Today, as different waves of innovations in quality management have lost momentum (Conti, 2005), leaders and managers have no methodology in place for including in their quality strategy key challenges that follow emerging complexity. Yet the integration of quality thinking and systems thinking is likely to become the next wave in innovations in quality management (Scharmer, 2009, p.79).

Value

Quality itself has no intrinsic worth and only when associated with "value" can it be perceived as a positive or negative attribute of an entity. Value is created through relations. Integrating systems thinking into the quality management provides an opportunity to view organizations as socio-cultural systems wherein value can be defined, measured, and managed.

According to Gharajedaghi (1999, p.56), value is one of the five dimensions of a socio-cultural system. They are:

- The generation and distribution of wealth, or the production of necessary goods and services and their equitable distribution
- The generation and dissemination of truth, or information, knowledge and understanding
- The creation and dissemination of beauty, the emotional aspect of being, the meaningfulness and excitement of what is done in and of itself
- Formation and institutionalization of values for the purpose of regulating and maintaining interpersonal relationship: cooperation, coalition, competition, and conflict
- Development and duplication of power, the questions of legitimacy, authority, and responsibility or, in general, the notion of governance

Each person develops his or her own understanding of value in life. A personal value often does not match a concept of value that is used in the organization where this person works because of the weak representation of value in the technologies with which he or she works. Merging an individual concept of value with the organizational one creates a third type of value concept: the embodied value of a product a person produces in his or her

organization.

Continuously increasing economic competition and technological change require a re-examination of the tools for understanding value concepts and developing a unified concept for specific organizations in the U.S. shipbuilding industry.
An examination of quality concepts through value in the shipbuilding industry provides an opportunity to consider the industry as a complex socio-cultural system as identified by Gharajedaghi. Such an examination creates the opportunity to define and assess quality through systems thinking that can be an integral part of a process of organizational learning (Santos et al, 2008) toward a new paradigm in continuous quality and value management.

Systems Thinking

Systems thinking emerged in the late 1940s as a mode of thinking that exposes people to the holistic nature and experience of existence (Checkland, 1983, p.668; Flood, 2010). Senge (2006, p.73, 124) states metaphorically that reality is made up of circles but that we perceive only straight lines. The essence of mastering systems thinking lies in seeing patterns where others see only events and forces to which to react. Caulfield and Maj (2001) state that "Humans need help in dealing with the new dynamic complexities of the shift to knowledge economies, and systems thinking has the historical intellectual integrity and practical application to provide the help to achieve this task." System thinking is one of the critical elements of core competencies of the engineering community that can increase learning curve effects in the product development processes and improve quality (Frankel, 1996, p.5).

One of the first applications of systems thinking in shipbuilding was Cooper's (Cooper, 1980) work to resolve a claim following a naval ship production project, as described in Sterman's book (Sterman, 2000, p.55). In this work System Dynamics (SD), one of the systems thinking tools, was merged with quality concepts through a re-work discovery process observed in complex programs.

A sub-category of systems thinking literature in management science arises in modeling and simulation. System dynamics modeling and cognitive mapping are two of numerous systems thinking tools that enable us to link theory and practice in a learning cycle (Jackson, 2006). System dynamics was developed as a method to cope with complex systems through modeling the feedback-loop structure of social systems (Forrester, 1971, p. 15). Forrester proposed that one of the necessary factors of high quality system dynamics diagrams is the introduction of the understanding of value into the concepts of quality.

Cognitive mapping is a more recent development conceived as a strategic management tool that helps in creating the future through making sense of the past (Eden and Ackermann, 2000).
Cognitive mapping and system dynamics modeling tools are successfully used in the aerospace industries (Twomey, and Rhodes, 2009; Wirsbinski, 2008) construction, power, and energy industries (Howick, Ackermann, and Andersen, 2006) and shipbuilding industries (Coyle and Gardiner, 1991; Munitic et al. 2008; Clark, Graves, Sheehan, 1983; Jin, 2008; Cooper, 1980). The experiences in these industries are a good resource for modeling and analyzing socio-cultural systems in the non-commercial sector of the U.S. shipbuilding industry.

Shipbuilding is a significant manufacturing hub, symbiotically connected to its supply chain industries, serving as a major platform of technological integration, a critical component of the country's defense, and an important mode of transportation of people and cargo. Existing situational research based on methodologies for this stage of industry development did not identify a clear path to the future, as the industry experienced and experiences conflicts between quality, production, and cost. Tools available to date do not apply and new tools have yet to be developed for all industries and their interrelatedness.

The proposed conceptual framework, i.e., the integration of quality management and systems thinking through value, includes the analysis of the historical aspects of the U.S. shipbuilding industry development from the first stage to the most recent stages of industry development. A combination of systems thinking, system dynamics and cognitive mapping provides an opportunity to project future industry development formulated with social factors based on changes in socio-cultural dynamics, the introduction of new technologies, and the re-examination of quality concept in historical perspectives. The end result will be the foundation for the development of new tools for process and product quality management.

Shipbuilding

A third body of literature includes concepts in self-organizing systems and complex systems. To a great extent, the non-commercial sector of the U.S. shipbuilding industry is protected by the government from exogenous factors as is the case in many other countries. The self-organizing principle of the non-commercial sector of U.S. shipbuilding industry is directed to the accumulation of engineering knowledge and innovation and to the creation of a vehicle for collective reputations (Tirole, 1996). In today's increasingly competitive economic conditions, attention towards the consideration of the role of shipbuilding, conceptualized as a self-organizing industry, has dramatically increased in the context of American industry as a whole (Danli, et al.. 2011; Wang and Gao, 2010). Shipbuilding, as a self-organizing industry, affects the national industrial potential and deeply penetrates all spheres of social life.

The casual loop diagram below (Figure 2) shows that the quality of employees and new product are the main drivers of industry efficiency. The more talent the industry has, the better the quality of the product it produces. The better the quality of the product industry produces, the more value industry brings to the associated social structures. The more value the industry brings to the social structures, the higher revenue the to industry. The

quality concept architecture development system must be updated continuously to improve efficiency and remain a source of competitive advantage.

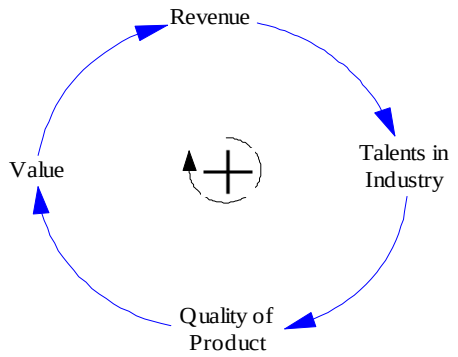

Figure 2. Competitive Advantage from Quality Concept Architecture Development

Prigogine's self-organization theory illuminates the efficacy of the model depicted in Figure 2. Prigogine's self-organization theory demonstrates that the existing quality concept architecture in the non-commercial sector of the U.S. shipbuilding industry is in equilibrium. In this equilibrium condition there is "molecular chaos"; movements of molecules do not show any preferred direction and correlations are sustained only weakly (see picture on the far left in Figure 3). This "chaos' can be used as metaphor to describe how employees might comply with existing top-down quality concept architecture in some U.S. shipbuilding organizations.

However, because the non-commercial sector of the U.S. shipbuilding industry can be said to develop from self-organizing principles, this condition, i.e., one of "molecular chaos' is not tenable. In this state the industry is overly sensitive to exogenous influence. Elements of individuated self-protection are its main attributes and based on the perception of unlimited resources. Self-destruction is taking place through quality management based on traditionalism.

When a "temperature gradient" is impressed on the system, through integration of systems thinking into quality management, employees are self-organizing in the best way to be able to "transfer heat", i.e. "value" within the new quality concept architecture (picture in the center of Figure 3).

If the "temperature gradient" is increased even more, here through better understanding and management of the integrated actions of recruiting, educating, and training of employees, we will be able to see an appearance of a phase change in self-generated whirls of activity, a new form of "heat transfer". This is a new non-equilibrium structure (picture in the right in Figure 3) that increases value production. This experiment is more than a century old. Prigogine (2005) saw in this experiment that non-equilibrium creates structures.

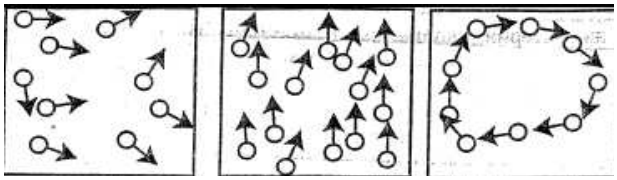

Figure 3. Three Types of Moving Particles (Prigogine, 2005)
On the left is molecular chaos in equilibrium condition; in the center there is disordered movement in vertical convection in a condition close to equilibrium; at the right emerge Benard's whirls, indicating high order in non-equilibrium conditions.

Prigogine's theory helps explain the concept of self-organization in industry. The theory provides a conceptual framework that encompasses concepts in quality, traditionalism, value, etc. and provides a model for justifying a new quality management approach applicable to different stages of the shipbuilding industry.

SUGGESTED RESEARCH STATEMENT OF OBJECTIVES

The era of globalization and the, evolution of technology and society have created a progressively increasing imbalance between the socio-cultural and technical aspects in organizations. We present here a theoretical construct to examine how these world processes have affected the perception and pursuit of quality and value in the non-commercial sector of the U.S. Shipbuilding industry. Many of the uncertainties with which we deal in the measurement and management of quality are traceable to a lack of understanding the links between quality and value. Convergence of quality thinking and systems thinking with emphasis on the value generation process in the system perspective are addressed.

In February 2011, Ashton B. Carter the Under Secretary of Defense for Acquisition, Technology, and Logistics stated in his remarks "… we will be looking at our industry sector by sector – from shipbuilding to professional services, and from stealth to space – because the dynamics are different in each sector. This [a comprehensive sectoral study of our industry] will not be a one-time snapshot, but rather an ongoing guide to us as we seek to sustain the health, vibrancy, and efficiency of the industrial base upon which our security depends." (Carter, 2011)

The author translated The Under Secretary of Defense for Acquisition, Technology, and Logistics' concerns into two research tasks:

1. Develop a framework for reviewing models of quality management in the U.S. shipbuilding industry through traditionalism. This task involves characterizing the current industry quality system and capabilities qualitatively and/or quantitatively, and examining how the industry quality system, capabilities, and business environment have changed over the past several decades.
2. Develop more robust models for a quality system in the shipbuilding industry to stimulate the penetration of systems thinking in quality management. This task justifies a need to introduce systems thinking to quality management to understand the links between quality and value in the non-commercial sector of U.S. shipbuilding and advise on future training needs informed by results.

Suggested Research Objectives

The focus and primary aim of the research is to explore the extent to which systems thinking can be converged, i.e. to enhance quality management tools to take account of systems thinking approaches, with quality management, to provide a better interrelation between the social and technical dimensions of organizations. The analysis will be focused on reviewing social sub-systems of one of the U.S. shipbuilding organizations rather than technical sub-systems, because managing for quality at the system level means the sharing of people's cultures and values and analyzing how they interact and cooperate.

OUTLINE AND JUSTIFICATION OF THE SUGGESTED RESEARCH METHODOLOGY

Proposed Methodology

This research intends to focus on the explanation, understanding and interpretation of links between quality and value. Many of the uncertainties with which we deal in quality, are caused by a lack of this understanding.

It is proposed that this research would use case study methodology.
"Case studies have been widely used in studies of organization behavior, especially in understanding organizational innovation and change, as shaped by both internal forces and external environment (for example, Biggart, 1977; Burns and Stalker, 1968; Lawrence and Lorsch, 1967; Pettigrew and Whipp, 1991; Pettigrew et al., 1992) (in Cassell and Symon, 1994)".

Because convergence between quality management and systems thinking is an organizational innovation and change, case studies will employ different methods in different combinations.

- Questionnaires should be used to understand employees' views, perception and experience of a quality concept employed by a company and expectations and impacts that modification of the company quality concept might bring. Specifically, they will be used to understand:
  - The quality program process (the management, the participation, the delivery);
  - Customer's role and level of involvement in the quality program;
  - Expectations and aims of being involved in the quality program;
  - Feedback on the findings, particularly feelings about the quality of product outcomes;
  - What changes, if any, have taken place;
  - Potential impact of the quality program on individuals;
  - What worked well and what didn't work;
  - How the quality program could have been improved;
  - Understanding of certain concepts or issues (i.e. science, education)

- Interviews should be used to provide further qualitative information on a research project subject after a questionnaire has been administered. Three groups from the engineering community (designers, engineers and managers) from four major disciplines (electrical, mechanical, piping, and structural) should be interviewed. Unstructured interviews should be used as a part of a case study and as a part of a survey. Cognitive/cause mapping should be used during interviewing.

- Participant observation should be used as an active participant and a researcher. The researcher should note and analyze questions that employees will ask during the interviews. This in itself is valuable information and can tell much about those employees. The researcher should keep a day-to-day diary to reflect her role, her influence on the encounter, her relationship with the employees being interviewed and her observations. Any written reports should be given back to the employees for their interest and personal comments (Dawson, 2009).

- Qualitative analysis should be used to model cascade methodology (Howick et al, 2008) to bring together cognitive/cause mapping and SD.

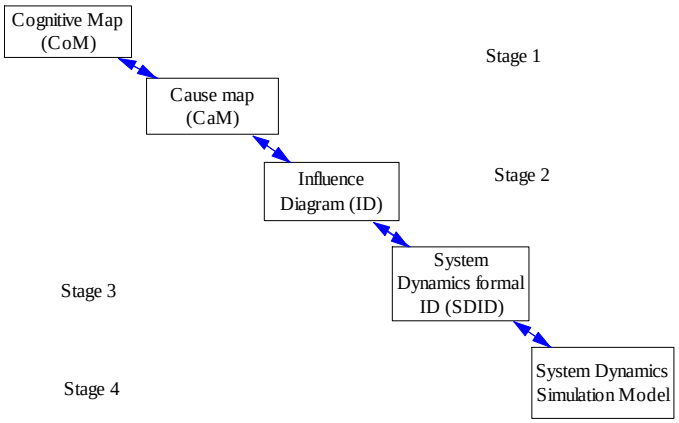

Figure 4. The Cascade Model Building Process (Based on Howick et al, 2008)

One of the important elements of the theoretical construct is the modeling of systems thinking intelligence (based on Skarzauskiene, 2010):

- System logic
- Pattern recognition
- Continuous learning
- Dynamic thinking
- Process orientation
- Understanding of mental models

Participation in the research should include the multiple shipbuilding organizations in different countries. Based on the number of participants, a sufficient number of case studies will be identified. The use of multiple case studies might increase the potential for future generalizability.
The researcher should involve the National Shipbuilding Research Program (NSRP), co-funded by the U.S. Navy and the U.S. Shipbuilding Industry.

CONCLUSION

This paper outlined a proposed approach to quality management and value enhancement in the non-commercial US shipbuilding industry, forwarding new concepts for understanding and managing quality and value by:

- introducing multidisciplinary education in the existing quality management system
- developing better understanding of quality-value relationships
- stabilizing customer requirements for quality management in the industry

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