As the definition of quality expands, the challenges faced by designers—with their inherent human capabilities and foibles—become more complex, requiring new strategic direction for the design process.

The Strategic Importance of Sustainable Quality

The Role of Human Endeavor Through Effective Design

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Quality is not the outcome of accidental occurrence; it is the result of purposeful design. Quality must be incorporated into every aspect of the design of products or services to guarantee that market and customer needs are attained. Furthermore, the natural law of entropy predicts that initial designs will degrade over time, generating decreased performance and capability. So not only do systems need to be designed with intentional quality built into them, but they also must be maintained in their excellent condition to ensure their continuing capability. Inattention to these two parameters—design and maintenance of intentional quality—can create lost economic value and social waste. These latter two additional parameters have become associated with the modern concept of sustainable quality, moving quality from a tactical methodology associated with specific products or services to a strategic approach that connects the impacts of those deliverables to society with the overall good of mankind both immediately and in the future.

Changing Definition of Sustainable Quality

The meaning of the term quality can be elusive—particularly when it relates to every aspect of a product or service's acceptability as judged by customers. James L. Adams notes that "We evaluate the overall quality of a product with a mixture of logical thinking and emotional response."[1] In this broadest sense, quality not only includes the functionality of the design but also customers' experiences as they interact with it. The definition of quality, therefore, goes beyond the physical characteristics and incorporates the emotional and

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psychological aspects of the customers' experiences as they interact with a product or service.

At its roots, therefore, quality includes those delivered characteristics that are intended to provide a conscientious transformation of customers' expectations into reality. The transformation process occurs when humans purposefully design quality into a product or service and ensure that the design is delivered correctly so customers receive the intended benefits and readily recognize its value. Furthermore, the original design capability that uniquely addresses customers' requirements must be maintained throughout repeated application by the supplier. This concept of quality, which has been the basis of the profession for many decades, emphasizes the fitness for use and ability to provide customers with a satisfying experience, which is inherent in the product or service design.

Quality, however, is not a static concept, and over time its definition has expanded to take on more strategic considerations for organizations and society at large. One driver of these changes is the linkage between quality and other concepts. For instance, quality is inextricably linked to the concept of value, which also has experienced changes in its definition over time. Originally, value reflected how well a product or service fulfilled its intended use. Now, perceptions of value include an economic or monetary component associated with a product or service's ability to provide customers with personal prosperity. Under these conditions, enduring quality is comingled with the accumulation of wealth, rather than focusing strictly on fitness for use, and this broader definition results in a far more strategic outcome.

As might be expected, however, this shift has not been accepted universally and has led to debate and the emergence of other considerations. Most recently, the definition of quality has taken on an even broader strategic framework, counterbalancing the emphasis on fitness for use and economic reward with the ability of quality systems to create a more harmonious and equitably sustainable society system or community. To attain the greatest common good, quality systems now also must incorporate the efficient, nonwasteful consumption of mankind's resources.

Clearly, the concept of sustainable quality changes as people's views of the world change. An understanding of the connectivity among the design and effective delivery of products and services that meet specific customers' requirements, the economic component of value, and the need to have a more socially responsible long-term view have led to a greatly expanded view of the important role of quality.

Human Influence on the Attainment of Sustainable Quality

One constant factor throughout the evolution of the development of quality, however, has been the role of humans in the process of designing for and delivering quality. Mankind always has had an internal compulsion to build and create products and services that fit customers' perceived needs. This endeavor uses available resources in a planned way to alter the environment and generate new, beneficial offerings.

Customers' perceived needs continually expand and become more complex, requiring greater variety and increasing the challenges faced by human designers. Fortunately, the natural ability of humans to be inventive makes it possible for product and service designs to deliver features that meet or exceed ever-changing market and customer demands. Despite the fact that quality now not only addresses the suitability of specific consumer deliverables but also their impacts of those on current and future results, it is important to recognize that the interaction between human creativity and design are still the keys to successfully attaining sustainable quality.

What exactly are the challenges currently faced by human designers in their pursuit of quality? As the role of quality has expanded to include bettering the current lives of people and the future promise to society, so has the complexity of issues that must be addressed in the development of sustainable quality systems. The likelihood of many interacting problems—disruptions in the effective and efficient provision of products/services that meet these broader requirements—increases. Resources are diverted when these complex problems occur, undermining the strategic pursuit of sustainable quality and creating a loss for society.

Russell Ackoff called these complex problems "messes" and wrote, "In an ideal state, as I conceive it, man would not be problem-free, but he would be capable of solving a continual flow of increasingly challenging problems."[2] Joseph A. Schumpeter recommended that accomplishing this objective rely on a "creative destruction" process, where an

innovative solution replaces the original process activities by implementing a redesign whose value is judged by the quality of its output and the results that it delivers to society.[3] This approach clearly relies on the ingenuity of humans to tackle and solve increasingly challenging messes in a way that addresses both current and future impacts.

That human ingenuity must be channeled properly by integrating it into work systems by designing "dynamic capabilities," as described by David J. Teece.[4] Dynamic capabilities allow organizations to survive messes by redesigning work and coordinating resources into new directions that meet evolving challenges. Collaboration among workers from varied disciplines ensures achievement of solutions that meet or exceed the strategic sustainable quality goals. Establishing a work environment where dynamic capabilities can flourish not only requires a commitment by the executive level of the organization but also the presence of a well-executed project management system that oversees application of project resources and controls the scope of work to achieve the required performance schedule.

Effect of Waste on Design for Sustainable Quality

Implicit in a product or service development system to generate dynamic capabilities needed to solve modern-day sustainable quality messes is the need to execute the design process in a way that minimizes waste. Waste is defined as any activity that adds cost or time but does not add value as judged from the customers' perspective or any activity that increases risk to employees through imposition of hazardous working conditions. Japanese quality uses three terms to identify different forms of waste, as described below:[5]

- *Muri* arises from poor decision making in the design process. For example, muri occurs when poor decisions are made related to inappropriate application of technology, unfavorable contract terms, or establishment of specifications that cannot be achieved.
- *Mura* occurs when the sequence of work activities is integrated poorly. A common situation involves work load that has an unbalanced flow across a supply chain. The work activities of all participants are not streamlined, and interruptions occur that disturb scheduled activities and cause schedule delays.
- *Muda* arises from poorly implemented operations (e.g., waiting time, bad quality parts, etc.). This type of waste occurs when quality problems arise or tasks are not performed efficiently.

From an organization-wide perspective, these three forms of waste are interconnected and combine to make the messes addressed by human designers even more complex. Executive muri (waste associated with irrational decisions at the highest levels of the organization) creates systemic mura (waste in the flow of processes and systems) which, in turn, generates muda (waste in workplace activities). Workers cannot eliminate these complexities in the course of normal operations or by using simplistic problem-solving methodologies. More thorough and robust approaches are required to eliminate this type of complex muda waste.

As the broader implications of these sources of waste are considered, it becomes obvious that they can take a toll on every aspect of sustainable quality—not just the acceptability of a product or service's ability to meet customers' expectations but also the system's ability to use resources effectively in generating the consumer deliverable without negative consequences. This scope exceeds traditional considerations of waste, clarifying that waste at any level ultimately affects society at large. Clearly then, the reduction of waste of all kinds must become an explicit consideration in the definition of quality for the design process—a requirement that ensures this expanded definition of sustainable quality is fulfilled.

This expectancy of the design process constitutes an enormous challenge because it intrinsically requires that the original design not only be capable of meeting current requirements with the nonwasteful utilization of resources, but it also assumes that the design will have forward flexibility—capabilities that will respond dynamically to an uncertain future. The demands on human designers, therefore, increase substantially under these circumstances.

Upon deeper consideration of these requirements a dichotomy arises. On the one hand, by its very nature, the provision of products and services requires the consumption of resources, which reduce the wealth of society over the long term. Genichi Taguchi observed that "just because products pass inspection does not mean that they are good." Sustainable quality is "… fundamentally based on the perspective that all waste creates a loss

to society of its scarce resources—either materially or a loss of energy and enthusiasm of workers."[6]

At the same time, however, demands for new products and services increases, and their creation generates benefits for society on a day-to-day basis. How then can the human designer satisfy these seemingly conflicting goals?

Human Dynamics of Successful Design

Some interesting—and unexpected—issues emerge as human designers set out to address these issues in their work. Addressing these issues requires an introspective understanding of the designers' role in both creating and solving these positive and negative outcomes. Furthermore, the approach used to bridge that gap successfully can require a very different mindset than is traditional.

Personnel Accountability

To minimize the creation of waste and reduce the associated resource losses to society, a design team must evaluate the sources of waste and identify their root causes. All too often these investigations lead to the unpleasant recognition that assigning responsibility for the causes points back to the designers who now are trying to improve the process. The biggest problem is not in finding the waste; the challenge is to assign responsibility for the propagation of the waste, which must be done to establish causality and to implement corrective actions that will reduce impacts on subsequent results. This means that elimination of the mess—waste—is inherent in the original design.

In a world where assignment of blame carefully is avoided in root cause analysis, there can be great reluctance regarding acceptance of accountability for designing an original process that inherently generates waste. The differentiation between assigning blame and ownership of the designer's role in promulgating a wasteful process can become blurry. In some circumstances, where the organizational culture deals harshly with perceived failures—it even can be risky.

Chris Argyris and Donald A. Schön comment, "The practitioner performs under stress; he must meet deadlines; he is constrained by time and money; and he faces a finite risk of failure that depends on the complexity of the situation and how far it departs from normal routine. To perform in these situations while aware of these [limiting] factors is to perform responsibly."[7] This analysis differentiates between recognizing that the constraints surrounding the design process may undermine its ability to minimize social waste effectively and the acknowledgement that the designers need to accept their accountability—and be willing to undertake concerted efforts to find better ways to achieve sustainable quality.

Importance of Failure

Humans naturally seek success, and that certainly is the case for design teams. When evaluating the relative merit of success and failure on the elimination of social waste and sustainable quality, however, these thoughts of Henry Petroski bear additional consideration. "Failures appear to be inevitable in the wake of prolonged success, which encourages lower margins of safety ... Failures, in turn, lead to greater safety margins and, hence new periods of success." Petroski continues by observing that: "No one wants to learn by mistakes, but we cannot learn enough from successes to go beyond the state of the art."[8] To rephrase Petroski's observations—the recognition and study of failures breeds greater attention to finding better ways to achieve design quality.

Pragmatic Application of Sustainable Quality

To achieve holistic performance in design requires a process that ensures achieving fitness for use from both the practical and experiential customer perspectives, contributing to the economic value equation, and minimizing negative impacts on society. Furthermore, these lofty objectives must be achieved in a way that maximizes the use of

human ingenuity while minimizing social waste—not just for the current time but for the largely unpredictable future. This outcome requires that leadership institute a strategic approach to sustainable quality that is based on new mindsets from the boardroom to the shop floor. Only if both the organization and its individual members accept this broader definition of quality and come to understand the ramifications of quality not just on markets and customers but also on society at large, can this challenge be met successfully.

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