Introduction

With the technological reality of the data driven technology keyed to the flow of information across the organization wide supply chain and the Net, the requirements for remaining competitive in manufacturing have become more demanding. Recently, high quality and efficiency were the necessary and sufficient conditions for staying in business. But not anymore. Now manufacturers must be able to rapidly develop and produce customized products to meet customer’s needs in changing and complex environment. Also, the requirements for economies of scale, based on traditional assumptions of mass production, are coming into direct conflict with requirements for economies of scope of mass customization by maintaining continuous innovation while using people and equipment to cost effectively produce smaller amounts of a range of products. It is to reduce uncertainty visa-a-vis environment that design is being developed and implemented. Thus, design is solving an ill-defined problem, not well-defined problem.

Analytical Survey of Existing Design Practices

Traditional design has its focus on its immediate users, mainly those who directly access the product / system / service. It is pushed by the suppliers. Quality design has its focus on customers, internal and external. This is more encompassing focus, in which it recognizes that those who develop, maintain and indirectly use the system are as much the customer as the direct users. Indirect users are those who are otherwise impacted by the system, such as suppliers or CEO’s. The customer focus is an underlined theme of almost all discussions on quality.

Traditional design has long recognized that without the commitment from CEO’s, a design project will not survive. In other words, engineering requires a project-based commitment by the CEO’s. Against this, the quality design goes one step further and requires that deliverers at all levels be passionately committed to the quality vision in general, and the quality vision of the design in particular. On the face of it, this type of commitment reduces, the project-by-project fight for the CEO’s (project leader’s) attention, and facilitates the project selection process.

The style of management in traditional design is mostly top down flow of orders and control, in that, the designers determine what should be done and then work to make sure what they have ordered is carried out. In quality design, designers act as problem solvers (though the problem solving is of incremental type and linearly predictable in nature).
In traditional design, designers, managers and quality inspectors carry out organizational control and technical quality control for product delivered. Against this, in quality design, reliability of design is of great importance to ensure quality and reliability in the components of product designed. Control is shifted to the worker or user (direct or indirect). In other words, the worker or user is responsible for producing an error free product / service and the analysis of error is not holistic and systematic.

A traditional design is done in a defined organizational boundary, mainly as a closed system, i.e., a well-defined problem. It works relatively in a static manner, in that, once the system has gone through its life cycle, i.e., the system is designed and implemented; the assumption is that it (system) will remain unchanged until the problem mounts to the point of requiring another round of life cycle iteration. Maintenance takes place in the form of trying to fix the bugs that are discovered while the system is operating. On the other hand, the quality design works as an open system, interacting with the external environment of the design organization (though it is incremental and linearly predictable) and has a dynamic nature, in that the continuous improvement is already a formal component of the system.

The traditional design has few processes in place for constant collection of data on the performance of design in operation. Therefore, any judgment regarding product design and their environment is mostly based on subjective judgments and opinions. This makes the traditional design subjective, opinionated and subject to ad-hoc maneuvers and personality clashes. Against this, the quality design emphasizes defining measurement and collection of data and facts that show the true value and performance of the design and its development.

Traditional design approach is to develop a design that works reasonably well. The approach is to fix the bugs as they appear after the design has become operational. In the quality design framework, zero error is the goal and is based on the idea of “Doing it right at the first time”. By definition, it assumes incremental and linearly predictable design organizational environment, internal as well as external.

In traditional design, reliability of the design is considered a costly activity requiring time and money. The manufacturing of the traditional design takes place in the form of trial and error and is based on the reputation of the hardware provider. Against this, in the quality design, the cost of design is the cost of its ownership, which includes future maintenance and loss due to
lack of reliability. This design is manufactured through an extensive and careful design phase and extensive reliability testing at manufacturing stage.

**In-adequacies of Existing Design Practices**

While the traditional design decisions are ad hoc delivered mostly in the mould of the manufacturer, the quality design paradigm primarily emphasizes the process aspect of the life cycle stages and is mainly entertained by the vast distribution and retailing network. The drivers for existing design practices are globalization, international competition and changing customer expectations. The product of system model is standard and its origin is the high volume mechanical manufacture. It comprises physical work systems, which emphasize material and energy processing. This model is insensitive to customer requirements of local market factor based on individual situations and its main concern is that the design information system accesses, communicates, process and distributes the already generated (design) information.

Thus, the concern of the existing design practices is the well-defined design problem. Described generically, the design problem forecasts system states, generates alternatives and selects design solution, i.e., the design information decision. When a design problem is well defined, the alternatives are generated the a priori, external to the decision situation. This is because the design problem information and the design problem environment information, which are needed for design alternatives information, and the design alternatives information is taken (assumed) completely known. This is a static view of the design environment. This renders the design problem to be an analysis problem for the system in *being*, primarily from the standpoint of procedural changes, which is sensitive to noise; the challenge being that the design computation is carried out correctly.
But, given the reality of the complex and ever changing product market requirements (implications of changing sales patterns; competition; infrastructure – organizational, transportation, IT & telecommunications; economic, social, political and cultural pressures; asymmetric business relations; population growth; etc.), so is the design problem environment - complex and dynamic, ever changing. As a result, it is the ill-defined design problem, which is to be resolved. A design problem is rendered ill-defined when design problem (goal) information, design environment information, and the design alternatives’ information is riddled with uncertainties, is not known completely a priori, and is to be generated endogenous to the design decision situation. What is significant is that, in the wake of the reality of the complex and ever changing design environment, it is the many factors, multiple criteria and a large number of alternatives that characterize dealing with and selecting the design information decision. This is a task of a continuous individual information origination, evaluation, selection and processing situation in the presence of uncertainty, which is a costly activity and calls for resources. Not recognizing this shift from the well-defined design problem to the ill-defined one leads to the design errors by the way of incorrect production of design information. This is due to distortion and noise, which in the end analysis leads to a system failure and, thereby, to the loss of competitive advantage. Incorrect production of design information due to design errors from
distortion and noise is the question of poor design integrity i.e. loss of information integrity in the design.

This brings the query to the question of the design error model. In a well-defined design problem, which is what the existing design practices emphasize, error is of inexactness of the design information decision – the information decision being determined the a priori, exogenous to the decision situation and, therefore, being given, i.e., fixed. There is no requirement to originate design information, i.e., information is treated as by-product and it has no value, only cost. Design error is thus in a fixed, i.e., structured, predictable design information decision (accounting for procedural changes). Against this, in an ill-defined design problem, which is the hallmark of problem solving in a complex and changing environment, error is of incorrectness of design information decision – the design information decision being determined endogenous to the decision situation and, therefore, being originated and evaluated for selection in every situation. Design error of distortion and noise, therefore is in a flexible, i.e., unstructured, unpredictable design information decision (which cognizes the internal and external environmental changes in respect of the design organization).