Research Methodology: Systems Approach to Production System Design

In the traditional and current design approaches, above inadequacy of not recognizing the shift in the design problem nature arises mainly because a system in the traditional engineering sense is defined as rigidly connected interdependent components and sub-systems. However, requirement to accommodate environmental reality for each component, sub-system and system as a whole suggests that a system should be seen as a loosely connected organization. This is because a system in a changing environment comprises of components and sub-systems made up of: objects, which are mechanistic (this the traditional engineering accepts) and which are abstract (e.g., sales statements, marketing forecasts, budget, etc.), people (internal and external users of the system development and implementation life cycle), communication (including communication hardware), norms (standards), rules and procedures, policies, financial mechanisms etc.

The above renders system a potential source of information and necessitates it to be defined as an interdependent network of information variables, which in situation even act on themselves. This presents the process of design in its information system (IS) view, which in the manner of solving an ill-defined design problem, now, continuously originates, evaluates and processes a flexible design decision (as against the fixed design decision) in a complex and ever changing environment.
This calls for a system’s approach by designing for an optimum informational interconnection of various objects, which facilitate effective and economic processing of information for an individual decision situation. Thus, what is arrived at is a transformation (shift) of traditional collective design decision requirement to an individual design decision for a specific situation representing ever-changing customer requirements. Said differently, the design problem has moved from being that of mass production of standard product in large volume to that of mass customization for an individualized use.

In the process of solving an ill-defined problem, which consists of multiple design decisions, each decision stage, which cognizes environment, is an information origination and evaluation process and has uncertainties. As a result, design IS becomes a continuous individual
information origination, evaluation and processing situation in presence of uncertainty. This leads to information errors by the way of distortion and noise at each decision stage of the design IS view and in the flexible information decision delivered. This brings in the issue of Information Integrity (I*I) and hence, the issue of loss of I*I in objects. It is by minimizing these information errors that the system’s effectiveness and the economy can be improved and for that, it is I*I that will have to be controlled. For competitive advantage, requirement then is to minimize informational errors due to distortion and noise, i.e., to ensure correctness aspect of information, which also includes exactness aspect. This demands going beyond “reliability” requirement and to ensure accuracy, consistency, and reliability, i.e., Information Integrity (I*I) of information system and information there from. I*I is the dependability and trustworthiness of information.

Before progressing further, at this stage, it should be of help to say few words about integrity attributes of accuracy, consistency and reliability. Accuracy attribute (A) is defined as the degree of agreement between a particular value and an identified source. It can be assessed by identifying the relevant established source (standard) and by determining an acceptable tolerance. Against this, Consistency (C) is defined as the degree to which multiple instances of a value satisfy a set of constraints. The multiple instances may exist across space (such as design databases or systems) or over time. Reliability attribute (R) is a little complex attribute to define. Traditionally, it refers to a wide range of issues relating to the design of large systems, which are required to work well for specified periods of time. However, it is also seen as ‘completeness’ issue. Of course, the completeness requirement itself has two different aspects. One is that of “exactness” requirement. This requirement occurring due to the ever-present system “noise” in the “standard” product in high volume seeking business models under quality paradigm emphasizing “reduced defects” in system processing.
But, when concerned with reliability factor under correctness requirement of information, there are incompleteness issues due to “noise” and “distortion”. For the purpose of the investigation at hand, whether “inexactness” due to the ‘noise’ factor or “incorrectness” due to ‘distortion’ factor, both results in information item exhibiting error and therefore loss of integrity. As a result, reliability attribute of “correctness” aspect of information requirement in considering ‘completeness’ must account for both these possibilities. It is within this framework then the Reliability (R) can be heuristically defined as follows: it refers to completeness, currency and auditability of data/information. Specifically, design data/information is complete when all component elements are present (effects both of distortion and noise are counted). Design information is current when it represents the most recent value. And, design information
is auditable if there is a record of how it was derived and that record allows one to trace information back to its source.

For the purpose of design integrity, the measure of I\*I then can be built based on the measurements of integrity attributes A, C, R, which forms one of the results that the proposed research will pursue.

**The proposed research work will explore following design propositions:**

- A systems approach for designing an optimum informational interconnection of objects, which facilitates effective and economic processing of information for an individual decision situation.
- The process of solving an ill-defined problem, which consists of multiple design decisions, where in each decision stage, which cognizes environment, is an information origination and evaluation process and has uncertainties.
- This leads to information errors by the way of distortion and noise at each decision stage of the design IS view and in the flexible information decision delivered.
- The issue of Information Integrity(I\*I) and hence, the issue of loss of I\*I.
- By minimizing these information errors that the system’s effectiveness and the economy can be improved and for that, it is I\*I that will have to be controlled.
- For competitive advantage, requirement then is to minimize informational errors due to distortion and noise, i.e., to ensure correctness aspect of information, which also includes exactness aspect.
- This demands going beyond “reliability” requirement and to ensure accuracy, consistency, and reliability, i.e., Information Integrity (I\*I) of information system and information there from.

**Work Flow**

1. Analytical Survey of Existing Design Practices
2. Study of In-adequacies of Existing Design Practices
3. Analysis of failures in IS based view
4. Open system IS view for system to be
5. Information Integrity Technology Development and its applications
6. An extensive literature review with set of environment and system variables
7. Study of how the non-critical factors affect the critical factors in the design process
8. Experimental learnings: Manufacturing Companies & Educational Innovations
9. Analytical framework for systemic modeling
10. Data analysis
11. Cost benefit analysis of design
12. I*I Index for risk analysis
13. Conclusion

Work Plan

- **6 Months**: Analytical survey of existing design, study of in-adequacies in it and analysis of failures with Information System based view along with Literature reviews.
- **12 Months**: An extensive literature review with set of environment and system variables and analyze the role of non-critical and critical factors in the design process. Also, developing analytical framework for systemic modeling in design process. Participating in the workshops, conferences and presenting the papers
- **24 Month**: Thesis report writing, paper publications and presentations.