LITERATURE REVIEW

Literature review in the field of design studies is presented with special reference to power plant design, system design and quality. Research work on other related areas, e.g. total quality management, concurrent engineering, graph theoretical methodology, and Theory of Order Preference by Similarity to Ideal Solution are also referred. Further, the need is emphasized for an integrated approach to carry out research work for the development of Total System Design philosophy that encompasses the design aspects of the subsystems and their interdependence. Finally, the requirements of the proposed methodology are identified.

2.1 INTRODUCTION

Existence of design studies is said to be as old as the invention of the first mechanical aid; yet, the field of system design and quality in design are relatively new approaches and can be attributed to the recognition of the importance of the quality from the very basis of the design process, during the post-industrialization period. The roots of their origin are traced back in the disciplines of system studies and quality engineering in design process. These disciplines take a lot from different fields such as, system engineering, concurrent engineering, conceptual design, design for manufacturing, design for maintenance, etc., and hence a phenomenal amount of literature in the form of research papers, books, review papers, etc., can be seen dealing with one or the other aspect of these fields.

An attempt to review the whole range of literature is faced with the common problem of a diversified subject matter. Any single general framework for classification is not feasible due to the inter-disciplinary nature of the research problem and attempt in sequencing / grouping the literature would have to be objective specific.

In this chapter, an attempt is made to review the literature based on defined broad classes as well as identified literature features related to proposed work.
2.2 REVIEW ON THE BASIS OF IDENTIFIED CATEGORIES

To identify the new field of research work, and to know the state-of-art, extensive literature is collected in all the diverse fields of design, not only in the mechanical engineering field, but also in other related fields. The literature is research oriented, review papers, which explains only the concepts, for practicing engineers or original contributions with extensive bibliography. To understand and interpret the previous works on different aspects related to the formulation of the present research problem, the literature available in various sub-areas of the plant design and other specific literature are alone considered.

It is beyond the scope of this thesis to descriptively report all the references listed under the various headings. Therefore, an attempt is made to portray the entire literature in a format so that only a few research articles are covered in the explanation for each sub-area as a representative work in that particular area. It helps in deriving important inferences regarding the trend and potential for further research in that area.

The literature has not been exhaustive owing to the non-availability of all the journals and books related to research problem, and therefore, is only an indicative sample; nevertheless, it supports the development of the methodology for Total System Design (TSD) of the thermal power plant carried out in the thesis. The following few sections discuss only the major influential articles in various field areas which are very important to the basic formulation of the problem selected for the present research work.

2.2.1 Design of Power Plants

The selection of energy sources to generate electricity can be considered as one of the most important aspect in the decision process for the national power expansion system. The decision in this stage critically considers the future performance of the power plants. It often involves the consideration of numerous factors that encompass many different aspects of economic, social, political, technology development and environment, some of which can not be easily quantified in terms of monetary value. The depletion of fossil energy sources, public awareness
of safety and environmental problems, for example, have introduced several political and social issues which require careful assessment throughout the decision making and planning process for electric power generation. In addition to that, the issues of moral responsibility that this generation owes to next generation have brought about need to expand the planning horizon including far longer periods of time.

Therefore, the literature presented in this section is reviewed in order to observe the trends and to examine the current practices of design studies of thermal power plants in specific and power plants in general on the basis of system approach, reliability and quality analysis, concurrent engineering, modeling and simulation, etc.

Dudley [1972] emphasized that only if mutual interrelationships between engineering and environmental considerations are considered at the beginning of the planning stage a final design be developed that is both compatible with the local environment and efficient for its intended functions.

Kulakov [1984] presented a method for conducting experiments and analysis of the dynamics of a 300 MW power unit. The use of dynamic characteristics during the power adjustment of the automatic governing system and the design of units with the necessary adjustability was discussed.

Maffezzoni [1987] gave guidelines for the integrated design of modern control systems for fossil fired power units taking into account actual operating conditions and constraints related to boiler and turbine designs. Applications of advanced control concepts and their combinations with basic findings coming from operating experience and process modeling are considered with particular attention.

Nasrollah et al. [1988] described an approach which utilizes a relational database for data storage, accessible directly for computational purposes during different stages of plant design and for maintenance and expansion purposes. They also explained the additional benefits gained during the conceptual design stage.

Nakamura and Uchide [1989] presented the design of an advanced control system to regulate the temperature in the boiler of a thermal power plant. An autoregressive model was used to obtain plant transfer characteristics.
Zhu and Kazmer [2001] developed a design representation to model multi-attribute systems utilizing multi-dimensional clipping and transformation algorithms. Given a linear system characterization, three types of supporting information were generated for the decision maker: (1) a function matrix that describes the performance attributes dependent upon the decision variables; (2) a decision space that corresponds to the feasible decision set that meets performance requirements, and; (3) a performance space that represents the feasible performance region and the Pareto Optimal Set. The analytical method developed for solving these feasible spaces was described for a linear system model. A case study presented to demonstrate how to utilize the representation to locate a feasible solution and proceed to the desired trade-off of multiple attributes. Moreover, the potential incorporations of the representation with other influential design methodologies were discussed.

Pacheco et al. [2003] developed a methodology that will enable designers to create models with levels of detail and accuracy that correspond to the current state of the design process so that designers can create a rough surrogate model representing the system response when limited information is available. They presented a covariance-based approach for building multistage surrogates in the conceptual design stages and illustrated the use of the methodology in a thermal design problem for wearable computers. The surrogate model enables the designer to understand the relationships among the design parameters.

Bertr and Cook [1983] found that the analyses of power plants had been significantly automated using GSMP which is a general system modeling program that links together precompiled subroutines to model a system in which they then represent subsystems. The numerical solution was found by iterative methods. The topology of the power plant being evaluated is not restricted to a small class of configurations; different aspects can be explored by altering the arrangement of plant components. He described how GSMP has been used to apply methods from general system theory to the modeling of some power plant systems.

Kotas [1980] used the concept of energy to define the criterion of performance of thermal power plant. Different criterion are defined for plants with useful output expressible in terms of exergy and those without general methods for formulating criterion of performance for specific thermal power plants are outlined and a number...
of examples of applications of steadily operating plants of open and closed types are considered.

Edward [1979] described several methods for identifying problem and evaluating potential improvements in operating plants. The applications of these methods to operating plants should result in significant increase in plant capacity. To identify potential new plant problems will require the design engineer to acquire and apply some new skills. In addition he must have much better communication with plant operators and maintenance personnel.

Anthony [1983] described techniques being developed to monitor components online and to detect incipient failures. All of these systems will increase awareness of factors that influence component integrity and provide information and insight not previously available to utility personnel.

Kordan [1984] presented a mathematical model for reliability estimation of power plants. He discussed a procedure based on Markov state aggregation and used to determine the probability of power loss due to an emergency shut down of a generating unit. He also developed functional models of the main generating equipment of the power plant.

Lautala and Valisuo [1989] presented a hierarchal modular real time failure diagnosis system for technical processes. The symptom detecting modules are written in algorithm form and methods used are model based but e. g. vibration analysis could also be used. The application to failure diagnosis was used in a coal power plant.

Onodera and Kato [1993] presented a comprehensive successful maintenance program which can plan preventive maintenance using diagnostic techniques for the remaining life of each of the equipment. They also developed a diagnostic system for critical equipments of a power plant.

Maughan [2001] considered the effects of four basic deterioration mechanisms on generators; thermal, electrical, ambient and mechanical. Only those design factors which are directly related to deterioration were considered. These topics were considered comprehensively but in relatively non technical terms. It was concluded
that better understanding of these deterioration mechanisms should assist owners of
generators to implement better operating and maintenance practices, and thus will
reduce costs and extend reliable life of the generator.

Yang [2003] presented a failure prediction and processing scheme for
preventive maintenance via the example of thermal power plant by using a hybrid
Petri net modeling method endowed with fault tree analysis and Kalman filtering. The
proposed Petri net approach not only can achieve early failure detection and isolation
for fault diagnosis but also facilitates event count, system state description, and
automatic shutdown or regulation. The capabilities are very useful for health
monitoring and preventive maintenance of a system.

Roser et al. [2003] described a method for including the effects of uncertainty
in the evaluation of economic benefits of various design change options. The results
indicated that the most profitable change option sequence depends not only on relative
costs but also on the relative degree of uncertainty and on the magnitude of the
potential design defects. The method demonstrated how design change alternatives
can be compared using the engineering design of a beam.

The major drawback in most of the present studies in this domain is the lack of
procedures to integrate the different aspects of the design of thermal power plants in
an appropriate manner. Though some authors have discussed it, still specific attention
is needed in this domain. A better option looked be to develop a model based on
mathematical approaches to represent the integrated system design with quality and
reliability aspects.

2.2.2 Mechanical Engineering Design

Studies pertaining to the general mechanical engineering design are reviewed
under this section. The various steps in the conventional design process have been
reviewed to find out the present state of the design. The structural analysis as the basic
of the design process is also explored.

Pahl and Beitz [1984] explained the design process with four phases; (1) clarification of the task (2) conceptual design (3) embodiment design and (4) detail
design. The first phase involves the collection of the information on the requirements to be embodied in the solution and also about the constraints. It is followed by the drawing up and elaboration of a detailed specification of requirements list. The second phase involves the establishment of function structures, the search for suitable solution principles and their combination into concept variants. On the basis of evaluation, the best solution concept can now be selected.

During the third phase, the designer, starting from the concept, determines the definitive layout and develops a technical product or system in accordance with technical and economic considerations. The definite layout selected provides a check of function, spatial compatibility and so on. It is also at this stage, at the very last, that the financial viability of the project must be assessed. Fourth phase is the phase of the design process in which the arrangement, form, dimensions and surface properties of all individual components are finally laid down, the materials specified, the technical and economic feasibility rechecked, and all drawings and other production documents produced.

Ionescu [1982, 1987] developed a unitary methodology for the system and structural analysis of complex mechanical units. The methodology is applied to the spatial mechanisms that make up a rail motor, i.e., the diesel-hydraulic locomotive. The structurally complex system is considered in a progressive-modular manner. The evolution of this study comprises of the system analysis, the constructive-functional parallel analysis, the analysis of mechanisms composition, the determination of the number of independent cycles-mechanism complexity, the analysis of simple and complex kinematics chain mechanisms, along with determination of their characteristics and modular correlation of all these stages lead to solve the given problems and offer an efficient working tool. The parallel analysis on constructive and functional bases of mechanisms, links and kinematics couples reveals significant design peculiarities and differences. Thus, the constructive features of the mechanisms always exceed their functional requirements, ensuring reliability in operation. The identification of the simple kinematics chain mechanisms, components of the complex kinematics chain mechanisms, is achieved on functional and constructive bases taking into actual driving elements and following the flow of movement of the driven links. It can also be obtained from the graph-structural
Kusiak and Szezerbicki [1992] presented a methodology for a formal approach to specifications in conceptual design. The conceptual design can be viewed as a process of abstracting and modeling. In the conceptual design, a designer transforms a set of an object into a functional and then physical description. The conceptual design of mechanical systems consists of three stages; (1) specification (2) representation and (3) synthesis. The specification stage aims at providing requirements and transforming them into functions of the designed objects. It occurs at the highest level of abstraction and it must provide enough information for the synthesis process where functions are transformed into design components that are further synthesized into the designed objects. The proposed approach includes the following issues: specification of requirements, specification of functions, and incorporation of logic into functional and requirement trees (decomposition), representation of requirements – functions interaction by incidence matrix and optimization in the functional space. The AND/OR tree was used to represent requirements, functions and their relationship. An integer-programming model was applied for matching requirements and functions.

Pham and Yong [1993] discussed the different stages in design and proposed architecture for a computer aided preliminary design. The engineering design process can be generated and summarized as consisting of the following four stages; (1) preliminary or conceptual design (2) Detailed design (3) evaluation and (4) redesign, if the evaluation is satisfactory. Here, the authors have proposed an overall architecture for a preliminary design system that uses the genetic algorithm to produce multiple design concepts. The proposed architecture is suitable for any design task involving manipulating standard building blocks. Genetic algorithms (GAs), which are, guided stochastic optimization and search procedures have been found useful for design problem solving. The approach is based on using the genetic algorithm to manipulate standard buildings blocks to produce different design concepts. No prior knowledge of the design domain is required apart from what the available building blocks and how they can be connected together.

Sen and Grover [1997] found that engineering of a power project is a complex and technologically challenging process whereby the technological inputs are...
disseminated as the project develops. There is no single stage in the project that can be identified as having no engineering or technological input. Further, growing concerns over environmental conservation are greatly influencing the choice of technologies so as to satisfy the environment regulations. Engineering of such new areas of environment friendly technologies has to be done with great care. The process, however, requires an integrated approach and careful analysis of feedback in implementing the engineering.

This indicative literature review demonstrates the status of present design process and the importance of considering the structural aspects for the system design. The need for the structural analysis in the design is stressed and it would improve the analysis technique for the system performance.

2.2.3 Total Quality Management

Quality is an indispensable part of the design studies and this fact leads to the inclusion of the quality of the system in the design studies. Here, it is proposed to look into the total quality management, as currently perceived, on different grounds.

Quality can be defined in many ways. Crosby [1979] defined quality as meeting requirements and said that the only true measure of quality is through the cost of quality. Deming [1986] stated that the quality is a triangle involving the interaction of the product, the customer and the way he or she uses the product and the training of the customer. Oakland John recommended the use of Oakland model for understanding of the principles underpinning quality. Malcolm Baldrige National Quality Award [1992] defined quality as meeting customers’ expectations. Gravin [1987] outlined eight dimensions of the quality. Juran [1988] stated that quality means fitness for use which is parameterized by the dimensions of the quality and is measured by quality characteristics.

Badiru [1990] explained a systems approach to Total Quality Management considering all the interactions necessary between various elements of the organization, including people and machines. He developed a conceptual model for TQM system, which shows the integration of various sub-systems in an organization with respect to quality objectives. A systems approach to quality facilitates an
integrated awareness of the importance of quality throughout an organization. TQM must exhibit an appreciation for integration, advanced technology, revision of the corporate culture, modernization of production infrastructure and most importantly, the utilization of human resources. While making products quicker and cheaper is a major determinant of short-term competitive edge, better products are invariably the determinant for long-term survival.

Nordeen [1993] explained the total quality, which has evolved into TQM by placing more importance on pre-production processes-prevention, designed-in-quality and quality in every aspects of an organization. Even though the term TQM is often used, a consensus definition has not been published by any standard organization. Definition for TQM as well as organizational quality system and process are listed. TQM is a paradigm shift which is suggested from the five-why analysis. It also stresses that the all levels in an organization are involved in quality. The various aspects to achieve the quality through the five-why analysis are outlined.

Dong et al. [2004] examined characterizing the quality of the design performance by measuring the coherence of the description of related design concepts and events in design documentation. Latent Semantic Analysis (LSA) was used to analyze design documentation written by self-managing, cross-functional engineering design teams. The results indicated a statistically significant positive correlation between design document coherence and design performance, especially for poorly performing teams.

These studies reflect the state of art in the field of TQM for the industry. A growing acceptance of TQM in industry to get quality in every activity of the organization can be observed. This outlines the need for consideration of quality from the conceptual stage of the design, i.e. the quality being defined and evaluated at each and every stage of the design. It also reveals that a lot of work has been carried out for the quality of the thermal power plants. The effect of various parameters in individual has been explored; certain mathematical models and techniques have also been applied for evaluation and analysis of the system. However, instead of all these approaches, no mathematical sound system tool could be found which could yield the evaluation and analysis of the quality of the TPP considering a number of attributes altogether in a unified manner.
2.2.4 Concurrent Engineering

Literature reviewed in this section is concerned with concurrent engineering of the mechanical parts. Integration of the product and process design is specially emphasized. The concurrent engineering concept with TQM is basic to the total system design (TSD) concept to be proposed in the thesis and, hence, the various aspects of concurrent engineering presently available are outlined.

Kusiak and Park [1990] presented a methodology for decomposition of the design task into activities and modules. The methodology was based on clustering of design activities into groups that allow effective organization of resources (designers, analysts, software systems and procedures) required in the design process. The project decomposition allows determination of a potential group of activities that might be scheduled simultaneously; the precedence constraints among activities are improved; the project scheduling and management is simplified; and it creates an environment for improvement of effectiveness and efficiency of the project. Here, knowledge-based system is used to manage the design project. This system performs analysis which aims at exploring concurrency and reducing the design project make span.

Fragola [1993] investigated the applicability of reliability tools and practices to the needs of the design process particularly in the current age of system design. The key to successful design in the current era is to admit to and characterize uncertainties to allow a design to be specified which is sufficiently robust to meet the design goals despite the design uncertainties. He outlined an approach for characterizing uncertainty in a semi quantitative manner such that it is applicable to design reliability analysis.

Kusiak and Wang [1993] developed an algorithm for organization design activities in order to effectively produce an acceptable design. The relationship among design activities is represented with an incidence matrix and the corresponding directed graph. The triangularization algorithm is developed for organizing design activities to increase the efficiency of design process. The design process is simplified by identifying and analyzing design activities that are coupled. Also the sequence of activities produced by the algorithm reduced the product development time. Hence, in concurrent engineering, an attempt is made to perform the design activities
simultaneously rather than in series as in the case of traditional design. This results in reduction of the duration of the design project, cost saving and better quality of the final design. However, the concurrent strategy increases the complexity of the design process and makes it more difficult to manage.

Lu and Hogg [1996] described a power plant analyzer, a computer code for power plant dynamic and steady state performance analysis. It simulates fossil power plant systems in a user friendly manner. It provides a concurrent tool for power engineers to understand the complex and interrelated thermodynamic processes and operating characteristics of the plant.

Das and Acharya [1999] presented a simulation model considering 14 equipments/components as critical for the availability of the plant in order to select optimal maintenance policy that maximizes the generation of the thermal power plant.

Oliveto [2000] defined concurrent engineering as a systematic team approach in which all disciplines participate in the design and development of products/systems and related process simultaneously to obtain common objectives. He delineated the detailed processes and procedures to implement effectively and made specific recommendations to obtain the desired results.

Therefore, it can be concluded that concurrent engineering is a new product development concept which integrates the product and process designs, leading to speedily developed, low cost and high quality products. Even in concurrent engineering, the complete integration from the concept of the organization to the environmentally concerned end disposal of the product is not considered in the design context. Hence, a need exists to integrate complete design process in a unified manner.

2.2.5 Modeling and Simulation

An excellence survey of various approaches towards developing models for least cost investment planning is given by Anderson [1972]. A number of optimization approaches have been attempted including marginal analysis, simulation models, dynamic programming, linear, nonlinear and mixed integer programming.
Each of them has its own advantages and shortcomings. However, linear programming model has been successfully exploited to solve power expansion problems.

Masse and Gibrat [1956-57] defined ‘n’ different groups of homogeneous plants and considered each group as a single unit. Capacity of each unit is variable which is optimized. The objective function is the total discounted cut laid cost. Constraints are the capacity requirements to satisfy power demand, upper bound on capacity, and the maximum permissible investment. However, this model does not take into account generation and transmission costs.

Bergeman’s model [1964] divided a given region into a number of sub regions, and the total planning horizon into a number of sub periods. Three types of demands during each sub-period for every sub region are considered. Capacity of each plant is a variable. The objective function is the total cost of installation and power generation. The constraints are the capacity requirements to meet the demand of various sub regions during different seasons. Though this model is better than the Masse & Gibrat’s model, it does not incorporate transmission cost and transmission losses.

The objective function of Narshiman et al. [1970] model consists of fixed and variable costs. Fixed cost comprises the capital cost of power plant and corresponding transmission lines whereas, variable cost is the sum of the costs of power generation and maintenance. Variable are the capacities of the plants and the average power generated in each season. Constraints are capacity and generation requirements to satisfy maximum demand, upper and lower bounds during different seasons. Moreover, this model does not consider power losses, base and peak loads.

Gosai [1973] minimized the total cost, the sum of the annual fixed, generation and transmission costs of the system. The constraints are the peak and average demands. The results are presented at the end of a given planning horizon. There is no index for time period. Therefore, intermediate results after a certain time interval cannot be achieved. Further, peak load criterion, cost associated with transmission losses, seasonal effects and discounting of costs are not considered.
Salsingikar [1977] presented a model for power stations which meet the demands of load by a combination of heavy equipment (conventional steam turbine) and light equipment (gas turbine). Objective function is the sum of capital and generation costs of both the equipments. Constraints are the conditions to satisfy peak and off peak loads. The variables are the plant capacity and generation of the equipments. Anyway, this model also does not incorporate transmission cost and transmission losses.

Saha et al. [1979] formulated investment planning problem as a multi-divisional, multi-time period linear programming one. The objective has been to minimize the system cost considering existing and proposed plants for an optimal mix with constraints imposed by the instantaneous energy demand, peak demand and availability of plant. However, this model does not take into account upper bound on capacities, transmission cost and transmission losses.

Lou [1984] has discussed economic feasibility of thermal power plants taking in to consideration local conditions and resources. Guidelines were given for selection of optimum location, size and type of equipments for TPP.

Wang and Min [2000] developed a generation planning model that incorporated outage costs of customers as well as the utility. The purpose of this planning model was to determine the generation units to be constructed and the amount of power to be produced while the total cost (fixed and production) to a utility is minimized.

The literature reveals that there is a need to develop a computationally simple and efficient linear model for the selection of optimum expansion plans which will minimize the net present value of the total annual cost and will take care of various constraints like peaks, demands and size limitations etc.

2.2.6 General Literature

Graph theory has extensively been applied to a number of disciplines of engineering sciences as well as social sciences, Deo [1974]. It serves as a mathematical model of the system reflecting the structural characteristics. Its
usefulness to provide concepts, representation and methods for the structural analysis has led to successful results in many fields. It has numerous advantages over all other methods, especially in investigations dealing with the pattern of relationships among various system elements. Its application has resulted in a simple and accessible, yet powerful tool to build up models and possible solutions to deterministic / stochastic / random or discrete / continuous / time bound nature of problems related to various systems involving flow of information / entities / state change / logic, etc.

It can be safely said that graph theory serves as a mathematical model of any system that includes multi-relations among its elements because of its diagrammatic representations and aesthetic aspects. There exist a number of challenges to solve, yet some of the results in graph theory are very elementary in nature and can easily be used. This fact has been put to use in many fields outside mathematics and yet, the potential of this tool is only beginning to be realized. Graph theory is a subject of combinatorial mathematics and draws a lot from matrix theory, group theory, etc. In fact, the matrix representation of the graph helps to mould the problem to make use of computers for various complex operations and to drive useful results.

Graph Theory has been applied extensively in various disciplines to evaluate and analyze the systems in terms of their characteristics. Gandhi et al. [1991] used graph theory to develop an evaluation methodology for system reliability and was later used by Gandhi and Agrawal [1994] to evaluate and analyze the system.

Chai and Sekar [2001] presented a methodology using graph theory to determine the specific generator contributions to different loads and the transmission system usage of different utilities. A directed graph is formed with vertices representing buses and the edges representing transmission lines.

Donne et al. [2001] discussed two projects. In the first project a specialized power plant simulation tool ACSL / MMS has been used. In the second project, MATLAB SIMULINK tool was used to analyze and undertake control design studies on power plants originally simulated using ACSL / MMS. The advanced simulation tools, now available, facilitate the modeling and analysis of complex engineering systems. The potential benefits included improvements in plant design and in-process operation.

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Xing and Wu [2000] proposed a Stackelberg model between a build–operate–transfer (BOT) investor and an electric utility to negotiate a long term energy contract. The model was transferred into a two-level optimization problem and then solved by an iterative algorithm. In this model asymmetric pricing schemes were taken into account and were demonstrated by an illustrative example.

Graph theory has been applied for consideration of performance mainly in communication and mechanical systems. The use of this theory for performance considerations, however, will be rewarding, as inherent failure characteristics and the existing interrelations of these systems can be effectively modeled using this approach. This procedure will also be useful to recognize the most important and inseparable component of the system: humans.

Various approaches sometimes provide a range of alternatives to choose a better one among them. There are various mathematical tools available to arrive at a decision under such circumstances. One of these is TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), based on the concept that the chosen alternative should have the shortest Euclidean distance from the ideal solution and the farthest from the negative ideal solution (Hwang and Yoon, 1982; Chen and Hwang, 1992). This Multiple Attribute Decision Making (MADM) approach is also suitable for computer programming as observed by Ahluwalia et al. [1993]. They presented a methodology for the evaluation and optimum selection of roller bearings on the basis of TOPSIS.

2.3 INFERENCES OF CRITICAL REVIEW

The study of available literature as presented in sections 2.2.1 to 2.2.6 under various categories points out the limitations of the current practices in the design and analysis of thermal power plants / power plants. Although these are prescribed separately at the end of each section, yet some of the salient observations inferred from the review worth mentioning are as follows:

1. It is evident from the review that system approach, simultaneous engineering, quality management, reliability analysis and modeling and simulation in the design of thermal power plants / power plants are dealt separately by various
authors. There is no work to integrate all these aspects in a holistic manner. Thus it provides an ample opportunity and scope to carry out research in the area of total system design of thermal power plants.

2. All the components and subsystems contribute in different fashion in the overall performance of the thermal power plant individual as well as interdependence performances of these subsystems and components of such a large and complex system should be unified by using a suitable technique and to develop a mathematical model to get the overall performance measure, optimal selection and ranking of the thermal power plants. Thus research work can be carried out considering all these aspects from the very beginning phase of the thermal power plant finally to generate power in a unified manner.

3. Even though concurrent engineering and system approach are already being practiced; it is not available in the published form. From the concurrent engineering point of view, all the attributes in an organization should be integrated by taking into account the human aspects, work culture, feedback, governing policies, end users etc. hence, there is a need to develop an approach in an integrated way which provides true concurrent engineering environment.

4. The main purpose of this total system design approach is to design the quality of the system which is used to carry out the thermal power plant design process and not to design the quality of the thermal power plant.

These inferences give rise to the idea that there is a need to develop not only a technique but a complete methodology for total system design of the thermal power plants which will consider all the aspects of the identified literature features.

2.4 REQUIREMENTS FOR TSD OF A THERMAL POWER PLANT

Total System Design (TSD) is an integrated design approach which represents the complete design process considering all aspects related to man, plant and environment etc. In general to carry out the TSD of a thermal power plant, it must include the following:

1. Identification of attributes.
2. Identification of inputs and outputs of the design process.
3 System and structural analysis of the system.
4 Evaluation and selection methodology.
5 Mathematical modeling of the system for visual representation of components and their interactions.
6 Algorithms to compute and analyses.
7 Design flexibility to introduce and add new aspects of design without much change.
8 Account for man-plant-environment interaction in the design process.
9 Quality and reliability aspects of the design.
10 Techniques of evaluation of various aspects like quality, reliability and performance etc.
11 Database for various characteristics, alternatives, processes, techniques and design information.
12 Comparison and ranking techniques of various alternatives with a possible graphical user interface.

2.5 CONCLUSIONS

This chapter has reviewed the literature to facilitate the study of current state of research. The literature has been categorized into six broad groups. It is observed that, because of these groups not being mutually exclusive, a certain amount of overlap exists in the study. A look into the literature revealed some potential areas which will require future research attention.