

Preface

This book “Comparative Design of Structures” is devoted to study the essential of design philosophy, in particular, structural design. The purpose of this book is to explore the essentials of design activity in conceptual and philosophical point of view incorporated by structural design as the carrier. On the other hand, in our information era, it should not be underestimated the importance of using current computer technology to represent designer’s intelligent ideas during design processes, by which the past knowledge and experience of human being in design can be stored in computer.

As a matter of fact, design activities are the highest intelligence of human being and can be regarded as a series of decision making under uncertainties for approaching design goal(s). We also understand that design is a process of comparison between past samples stored in the mind of the designers who are doing the comparison, even though unconsciously, during design processes.

To simulate this procedure of the designer by means of computer is actually an artificial intelligence (AI) problem, and to store design knowledge in a knowledge base and to infer the design objective through AI are the tendency of design development nowadays. Therefore, using fuzzy theory for treating uncertain design environment and knowledge engineering for cumulating design knowledge into computer is the right way for accommodating the development tendency of design. In other word, we are entering in a new era, which is characterized by “Softening of the theories and hardening of the knowledge,” and among them, design development is including in this range.

How to use computer AI technology to develop future design procedure? How to inherit design experience for future usage? One have to develop a theoretical framework of how design is performed by human being and of how the design philosophies that a designer is adhered. This is why one has to emphasize the principle of “comparative design.”

For computerized “comparative design,” there are two crucial problems to be studied: First, the implicit comparative design activities are essentially an intelligent process, it must be represented by certain AI formulation for its implementation in

computer, and this is what Chaps. 1 and 8 have presented; Second is the understanding of the modeling of design object, i.e., to clarify the procedure of an entity system through its components by composition and decomposition. We fully use the advantages of the complexity of structure for realizing the modeling of composition and decomposition, and this is what the remaining chapters have presented in detail. Through structural design, the authors have modeled a structure into its fundamental elements and then assembled its composition through 1D to 2D and then 3D structure step by step for illustrating the essential processes of comparative choice. The authors have spent a big volume of this book in describing the comparative design choice in different level of structural composition, that enable the readers to make sense of that comparative design choice is the insight essential of the design. On the other hand, the book can be a reference book for design engineer or a reference text book for related undergraduate and graduate students.

Structural design is aimed to provide a good structure which satisfies the entire requirements in architectural aspect, economic aspect, etc. The design process is the integrity of human intelligence. Incorporating artificial intelligent technologies into CAD system, the intelligent CAD system (or ICAD) is then emerged. This is an important tendency for modern development of CAD technique, which represents the state of the art in this area.

This book “Comparative Design of Structures” is devoted to study the essential of design philosophy, in particular, structural design. An outstanding structural design is generated by creative originality of designer based on comparing different similar existing samples following to the law of structural behavior. Since the global layout and overall mechanical behavior are the core in structural conceptual design, it is important to point out that the number and the quality of accessible similar samples to compare, or the past experience of the designer, are the key in design, and doubtlessly, the knowledge engineering application will help in this regard.

The latter part of this book introduces the method of intelligent design based on knowledge engineering with fuzzy reasoning. As an example, the principles of comparative conceptual design of high-rise building are presented; these principles can be used in different fields as one of the generalized methodologies of intelligent design.

The idea of comparative design is based on human empirical cognition and fuzzy identification capability that reflect the creativity of the designer in a superior design alternative; however, it can never realize without the comparison with other similar existing samples in the past, on which the experiences of the designer were built. In an outstanding conceptual structural design, this innovative idea of designer should be compliant to mechanical behavior of structure, where the architectural aesthetics and the rational composition of structural elements are performed. For achieving optimum performance of structural behavior, a process of integration of intuitive experiences is needed rather than the details of computer structural

analysis. This is why we also provide in this book a set of “Best Practice” examples of structure and structural components with its merits and demerits for creating a comparative environment.

We address the principles of “understanding the correctness through examining the wrong” and “promoting creativity through comparison of cases.” Such a case-based reasoning method in artificial intelligence is proved to be effective by a series of successful examples in intelligent design from practice; certainly, it does work in the field of structural conceptual design.

In global sense, the digitization of comparative design can be concluded as a part of the discipline of “Quantitative Management.” Design is the bridge between a subjective function to an objective reality, which is essentially a series of decision making in the scenario context for approaching optimum function performance of reality. The design processes under the support of uncertain experience (or uncertain characteristics of cases) can be regarded as a series of decision making under uncertainties, while fuzzy reasoning capability of human being is most effective. One can utilize the artificial intelligence (AI) technology for digitizing the processes of design or quantized decision making as a problem of quantitative management based on fuzzy logic and AI, while the “Fuzzy-AI Model” will work correspondingly [6–8].

The “Fuzzy-AI Model” is based on simulating the capability of fuzzy reasoning of human being to make decision from corresponding information. For most of the human, intelligence is come from their intensive capability of processing massive fuzzy information, then to simulate such ability of human being could be exactly regarded as the art of artificial intelligence, that is why the model is named. “Fuzzy-AI Model” also reflects the idea of comparison of corresponding information, while the model used for design purpose must be naturally accessed.

Another objective of this book is to unify the concepts of comparative design with the quantitative management by using “Fuzzy-AI Model.” An important statement is that essentially, the quantitative management means to use a series of digitized expression of decision making, which is the combination of decision science and AI technology for exploring the insight relation of these two disciplines. On the other hand, design processes are exactly a series of design decision making, and the principles of digital quantitative management make it possible to unify both comparative design and management through computer environment.

This essential theoretical development in methodology would potentially follow with a wide area of different applications, including the comparative conceptual design of structures presented in this book. We look forward to the blossom of perspective applications of digitized theory, both in management and in engineering design; it is the aims of the authors to explore the insights of the problem using structural design as a window.

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Concepts and Methodologies

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