SUMMARY OF Ph.D. DISSERTATION

School	Student Identification Number	SURNAME, First name
Integrated Design Engineering		INOUE, Masato

Title

Design Method for Obtaining Diverse Design Solutions Based on Emergence

Abstract

Design processes are broadly divided into two types: early processes and late processes. It is difficult to apply the conventional optimization methods in the early processes of design referred to as conceptual design and preliminary design. In these early design processes, many design conditions are not completely defined. A design objective gradually becomes clearer as the processes advance from the early processes to the late, allowing us to add other design conditions. In such design processes, many diverse design ideas must be obtained under the constraint of unclear design conditions by globally searching within the solutions space. At present, in these design processes designers depend on either their intuition or their experiences. The present study proposes a design method for obtaining diverse design solutions under such design conditions by globally searching within the solutions space and a 3-dimensional form-generation system by applying the proposed design method to artifacts design. The objective of the present study is to evaluate the effectiveness of the system to obtain diverse design solutions.

Chapter 1 describes design studies and the objective of the present study.

Chapter 2 proposes a design method based on emergence, consisting of a generation process and an optimization process, which can obtain diverse design solutions. Comparing the proposed method with the conventional optimization methods indicates the possibility of obtaining diverse design solutions. The basic structure of a system for obtaining diverse forms is proposed.

Chapter 3 proposes a 3-dimensional form-generation method using the 3-dimensional cellular automata. The form-generation method referring to the emergent evolution and the diversity of an organism imitates the two properties concerned with diverse morphogenesis in the developmental process of an organism: induction and apical dominance. In order to verify the effectiveness of the proposed method, the method is applied to the form design of chairs, and the diversity and the efficiency of searching solutions are analyzed.

Chapter 4 applies the form-generation method to the structural design problem by adopting the optimization process. An optimization system, using the optimality criteria method, is proposed for optimizing diverse design ideas obtained in the generation process. The proposed system obtains design solutions of adequate diversity whereas the conventional optimization method obtains a unique solution.

Chapter 5 applies the form and structural design problems. Diversity analysis of the design ideas is conducted using multidimensional scaling. The proposed system is effective for obtaining diverse satisfactory design solutions of form and structure. This suggests the possibility of utilizing the proposed system for a design support system of industrial design and engineering design.

Chapter 6 summarizes the above-mentioned results.