

Theory of Design

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This talk gives an introduction to my book, *A Generative Theory of Shape* (Springer-Verlag, 550pages). The purpose of the book is to develop a generative theory of shape that has two properties regarded as fundamental to *intelligence* - maximizing transfer of structure and maximizing recoverability of the generative operations. These two properties are particularly important in the representation of *complex* shape - which is the main concern of the book. The primary goal of the theory is the conversion of complexity into understandability. For this purpose, a mathematical theory is presented of how understandability is created in a structure. This is achieved by developing a group-theoretic approach to formalizing transfer and recoverability. To handle complex shape, a new class of groups is developed, called *unfolding groups*. These unfold structure from a maximally collapsed version of that structure. A principal aspect of the theory is that it develops a group-theoretic formalization of major object-oriented concepts such as inheritance. The result is an *object-oriented theory of geometry*.

The algebraic theory is applied in detail to CAD, perception, and robotics. In CAD, lengthy chapters are presented on mechanical and architectural design. For example, using the theory of unfolding groups, the book works in detail through the main stages of mechanical CAD/CAM: part-design, assembly and machining. And within part-design, an extensive algebraic analysis is given of sketching, alignment, dimensioning, resolution, editing, sweeping, feature-addition, and intent-management. The equivalent analysis is also done for architectural design. In perception, extensive theories are given for grouping and the main Gestalt motion phenomena (induced motion, separation of systems, the Johansson relative/absolute motion effects); as well as orientation and form. In robotics, several levels of analysis are developed for manipulator structure, using the book's algebraic theory of object-oriented structure.

The book can be read on-line at the following site of the publisher Springer –Verlag:
<http://link.springer.de/link/service/series/0558/tocs/t2145.htm>