A Generative Theory of Shape
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This talk gives an introduction to my book "A Generative Theory of Shape" (Springer, 2001). The purpose of the book is to develop a generative theory that has two properties regarded as fundamental to intelligence: *(i) maximizing transfer of structure* and *(ii) 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 invented, called "unfolding groups," which from a maximally collapsed version of a structure, unfolds it. A principal aspect of the theory is that it develops a new algebraic formalization of major object-oriented concepts such as inheritance. The consequence is an *object-oriented theory of geometry*. The book establishes a representational language for product and project description, that is interoperable by virtue of the principles on which the theory is based: transfer (reusability) and recoverability (traceability). Most crucially, in this theory, *intelligence* is brought into the very foundations of geometry.

"Exile" (1992), M. Leyton

The book gives extensive applications of the theory to human and machine vision, robotics, software engineering, physics, CAD/CAM: *e.g.*, it gives detailed insights into part-design, assembly and machining; and within part-design, an extensive 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 robotics, several levels of analysis are developed for manipulator structure and kinematics. In software, a new theory is given of the principal factors such as text and class structure, object creation cloning and modification, as well as inheritance and hierarchy prediction. In physics, a new theory is given of the conservation laws, and motion decomposition theorems in classical and quantum mechanics. In perception, extensive theories are developed for Gestalt grouping criteria, orientation and form, the prototype phenomena, and the main Gestalt motion phenomena (induced motion, separation of systems, the Johannson relative/absolute motion effects). Springer-Verlag allows the book to be viewed on-line at institutions that have a Springer subscription.

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