Combinatorial Models of Physical Behavior for Computer-Aided Design

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Abstract

For historical reasons, computer-aided geometric design and engineering analysis have emerged as two separate disciplines that are only weakly connected, because they appear to rely on distinct mathematical models and operate on incompatible computer representations. Unfortunate consequences of these incompatibilities include slow and inefficient design-analysis cycle, difficulties in integrating multiple analyses on a common design model, and more generally lack of adequate computer tools for describing physical laws and simulating behaviors of engineering artifacts.

In this talk, I will describe our ongoing efforts to bridge the gap between geometric design and engineering analysis in terms of unifying combinatorial models and principles. In particular, if distributions of physical quantities are represented as k-cochains, then a small number of operators (including boundary, coboundary, and dual) appear to be adequate for describing a variety of behaviors and applications. Application of these concepts should lead to substantially higher-level engineering languages and more automated tools for computer-aided design and analysis. One such application currently under develop-

ment at the University of Wisconsin is an interactive system for creating, editing, and transforming intuitive geometrical descriptions of physical laws and behaviors.