

AN INTRODUCTION TO CATASTROPHE THEORY AND ITS APPLICATIONS*

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Abstract. This article is divided into two parts. In the first we give a description of the basic theorems of elementary catastrophe theory, along with heuristic explanations of why these theorems are valid. In particular, the main ideas in Mather's proof of Thom's classification theorem are presented.

The second part contains three applications of catastrophe theory to the buckling of beams, optics, and convex conservation laws. In these sections we attempt to state the problems precisely, to show how catastrophe theory may be used in a mathematically rigorous fashion, and to state what new information can be obtained by the use of catastrophe theory.

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Introduction. During the past decade catastrophe theory, created by René Thom in his book *Structural Stability and Morphogenesis* [32], has generated substantial interest among both mathematicians and users of mathematics. Various comments about catastrophe theory have ranged from "the first theory to explain how a continuous change of parameters can cause discontinuous phenomena" or "the type of mathematics necessary to study qualitative problems in biology and the social sciences" to "some nice observations surrounded by totally unwarranted speculation." The truth, as usual, probably lies somewhere in between.

There now exist several expository articles describing catastrophe theory to the lay audience ([37], [24], [29], [27], [54], and [30]) and several expositions concerned with the technical theorems—first proved by John Mather [19]—which require relatively large investments of time and energy for most mathematicians to absorb and appreciate ([5], [36], [35], [50], [60], [55], and [21]).

Our purpose, in the first part of this article, is to give concise but complete descriptions of the basic theorems of elementary catastrophe theory along with heuristic descriptions explaining why these theorems should be true. In the second part we describe some applications which—we hope—will indicate some of the power and limitations of this theory.

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Catastrophe Theory And Its Applications

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