

# AN INTRODUCTION TO CATASTROPHE THEORY AND ITS APPLICATIONS\*

MARTIN GOLUBITSKY†

**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 Applications

**Y.-C. Lu**



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distinguished participants The conference aroused considerable interest and many mathematicians who were not specialists in the fields covered by the conference expressed their desire to attend the conference sessions in addition scientists from the Battelle laboratories came to Seattle to learn of developments in these areas and to consider possible applications to their own work In view of the attendance of these mathematicians and scientists and in order to enable the expositions of the experts to be intelligible to this wider audience I invited Professor Yung Chen Lu of Ohio State University to come to Battelle Seattle in advance of the actual conference to deliver a series of informal lecture seminars explaining the background of the mathematical theory and indicating some of the actual and possible applications In the event Yung Chen Lu delivered his lectures in the week preceding and the week following the actual conference so that the first half of his course was preparatory and the second half explanatory and evaluative These lecture notes constitute an expanded version of the course

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