Fuzzy Measures of a System's Effectiveness - An Application to Problem Solving [1]

MICHAEL GR. VOSKOGLOU
School of Technological Applications
Graduate Technological Educational Institute (T. E. I.)
Meg. Alexandrou 1, 263 34 Patras
GREECE
voskoglou@teipat.gr , http://eclass.teipat.gr/eclass/courses/523102

Abstract: They appear often situations in a system's operation characterized by a degree of vagueness and/or uncertainty. In the present paper we use principles of fuzzy logic to develop a general model representing such kind of situations. We also present 3 alternative methods for measuring a fuzzy system's effectiveness. These methods include the measurement of the system's total possibilistic uncertainty, the Shannon's entropy properly modified for use in a fuzzy environment and the "centroid" method in which the coordinates of the center of mass of the graph of the membership function involved provide an alternative measure of the system's performance An application of the above results is also developed concerning the Problem Solving process and two classroom experiments are presented illustrating the use of our results in practice.

Key Words: Systems Theory, Fuzzy Sets and Logic, Possibility, Uncertainty Theory, Problem solving.

1. Introduction: Systems' Modelling and Fuzzy Logic

A *system* is a set of interacting or interdependent components forming an integrated whole. A system comprises multiple views such as planning, analysis, design, implementation, deployment, structure, behavior, input and output data, etc. As an interdisciplinary and multi- perspective domain systems' theory brings together principles and concepts from ontology, philosophy of science, information and computer science, mathematics, as well as physics, biology, engineering, social and cognitive sciences, management and economics, strategic thinking, fuzziness and uncertainty, etc. Thus, it serves as a bridge for an interdisciplinary dialogue between autonomous areas of study. The emphasis with systems' theory shifts from parts to the organization of parts, recognizing that interactions of the parts are not static and constant, but dynamic processes.

Most systems share common characteristics including structure, behavior, interconnectivity (the various parts of a system have functional and structural relations to each other), sets of functions, etc. We scope a system by defining its boundary; this means choosing which entities are inside the system and which are outside, part of the environment.

The *systems' modelling* is a basic principle in engineering, in natural and in social sciences. When we face a problem concerning a system's operation (e.g. maximizing the productivity of an organization, minimizing the functional costs of a company, etc) a model is required to describe and represent the system's multiple views. The model is a simplified representation of the basic characteristics of the real system including only its entities and features under concern. In this sense, no model of a complex system could include all features and/or all entities belonging to the system. In fact, in this way the model's structure could become very complicated and therefore its use in practice could be very difficult and sometimes impossible. Therefore the construction of the model usually involves a deep abstracting process on identifying the system's dominant variables and the relationships governing them. The resulting structure of this action is known as the *assumed real system* (see Figure 1). The model, being an abstraction of the assumed real system, identifies and simplifies the relationships among these variables in a form amenable to analysis.

[1] The main body of this paper was presented in the form of a plenary lecture in the 16th WSEAS International Conference on Systems, Kos Island, Greece, July 14-16, 2012