COMPARISON BETWEEN GENERAL SYSTEM THEORY and SYSTEMS APPROACH in APPLIED SCIENCES (*)

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> «I believe we are leaving one cultural and technological age and entering another;..... The socio-technical revolution we entered may well come to be known as the **Resurrection**»
>
> **R.L. Ackoff (Ref. [1], p. 661)**

In this article, a comparison is made between Generel System Theory (G.S.T.) and Systems Appproach in Applied Sciences. These two have been considered as if they were the scientific products of the above mentioned **Resurrection.** The purpose of the author is not to put these new scientific truths into a circumcribed area, but to whisper them, with their main characteristics, to the ears of open-minded scientists in order to encourage discussion.

My assertions about G.S.T.are based primarily on writings of von Bertalanffy and my own opinions about Systems Approach based on

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the lectures given by H. Doğrusöz and M. Celasun and the writings of Ackoff. Some of the conclusions that I have reached are based on my discussions about the subject with K. Arman.

The presentation of this paper is as follows: First, similar aspects are discussed and then the differences between them are looked into. Thirdly, the answer to the question «what interractions are there between G.S.T. and Systems Approach?» is searched. Consequently, what has been said about the subject is summarized as a conclusion.

Similarities :

The similarities between G.S.T. and Systems Approach in Applied Sciences are subsumed into the following groups.

End Products of the Machine Age : From the point of Ackoff's classification and identification (see. Ref. [1]), The Machine Age, the age that we are leaving, has the doctrines of reductionism and mechanism as its basis with the analytical mode of thought. The Systems Age, the age that we are entering, has the doctrine of expansionism, teleology and a synthetic (or systems) mode of thought.

The transition was because the doctrines and mode of thought of the Machine Age couldn't answer all the questions asked and couldn't solve all the problems which arose. As Emery [11] (*) warned «.....it might happen if some influential group of scholars prematurely decide that the time come for a common conceptual framework. p. 12.» and then, the technology led scientists to think not in terms of single machines, but in those of «systems». von Bertalanffy [6] mentions this as «Then, however, something interesting and suprising happened. It turned out that a change in intellectual climate had taken place, making model building and abstract generalizations fashionable. Even more; quite a number of scientists had followed similar lines of thought. p. 13». These lines of though produced a numberof new disciplines for each of which the concept «systems» has a critical role.

The new disciplines are; Classical System Theory, Simulation, Compartment Theory, Axiomatized General System Theory ,Graph Theory, Net Theory, Cybernetic, Information Theory, and, Systems Sciences

(*) Numerals in the brackets [.....] represent the number of the reference listed at the end of the article.

Of course, one cannot consider these new disciplines as disjoint subsets of scientific studies, and one must not forget the fact that no science has ever been born on a specific day.

Classical Systems Theory and Aximoatized General System Theory leave their fields of study to the General Systems Theory whose subject matter is the formulation and derivation of those principles which are valid for «systems» in general (see. Ref. [6] p. 10 ff.).

System Engineering, Operations Research, and Human Engineering used to be included in Systems Science. Later, in the 1950' s, Operations Research grew rapidly and has been seen as one of the scientific disciplines with its own methods and methodology. Systems Approach in Applied Sciences, sometimes adopted as Systems Research, is one of the typical utilizers of Operations Research.

In view of the above discussion, General System Theory and Systems Approach in Applied Sciences can be considered as end products of the Machine Age.

Common Features : All theories produced by new lines of thought have certain features in common. von Bertalanffy has shown these common features in detail (see. Ref. [7] p. 14. ff.). Briefly these are:

— They agree in the emphasis that something should be done about the problems characteristics of the behavioral and biological sciences.

— These theories introduce concepts and models novel in comparison to physics.

— These theories particulary concerned with multivariable problems

— These models are interdisciplinary and traced to the conventional fields of science.

— Concepts like wholeness, organization, teleology and directiveness were considered as unscientific until the new lines of thought appeared. These theories take the above concepts seriously and amenable to scientific analysis.

Implications of Aims : The interdisciplinary nature of concepts, models and principles applied to «systems» provides a possible approach toward the unification of sciences. Boulding [9] claims that «G.S.T. is the skeleton of science in the sense that it aims to provide a framework or structure of systems on which to hang the flesh and blood of particular

disciplines and particular subject matters in an orderly and coherent corpus of knowledge. p. 208.». Hence, one of the objectives of G.S.T. is the unification of sciences and, in order to do this, it looks at sciences as a whole and benefits from whatever other disciplines have developed. The Systems Approach in Applied Sciences takes the system in which the problem arose as a whole and, in a sense, it is an interdisciplinary approach. That is to say, Systems Approach also benefits from the development of disciplines,.

The other similarity ,which is the implication of their aims is as follows; G.S.T. wants to minimize the duplication of efforts in scientific studies. Thus, it provides optimization in the use of resources in its field of study, i.e. scientist. It is well known that one of the main characteristics of the Systems Approach is the optimal usage of the resources in man-machine systems.

Differences :

Pure Science vs. Applied Science : The first difference between G.S.T. and Systems Approach arises from being a pure or an applied science. von Bertalanffy [6] claims that «G.S.T. is a logicomathematical field whose task is the formulation and derivation of those general principles that are applicaple to systems in gerenal p. 253.». Thus, General Systems Theory attempts to look at science as a body of facts, laws and theories (logicomathematical field) and therefore, it can be considered as a pure science. On the other hand, as Ackoff [3] mentions «science refers both to an activity-the process of controlled inquiry-and to the product of that activity-a body of knowledge ..... p. 52.». From this point of view, Systems Approach looks at science as an activity, and knowledge as its product. Hence, Systems Approach is an applied science.

The above discussion will lead us to see the differences between the aims of G.S.T. and Systems Approach. So far, we have seen that one of the main objectives of G.S.T. is to develop general principles that are applicaple to «systems» in general while the Systems Approach provides a basis for more effective designs and operations of systems. Consequently, the basic aim of G.S.T. is to develop universal laws applicaple to all systems and the basic aim of Systems Approach is problem solving.

Usages of Concepts : The concept «interdisciplinary» is used in order to discover relevant communications among all disciplines and is used for the development of a pure science in G.S.T.. On the other hand, the use of the concept «interdisciplinary» in Systems Approach is to treat the Systems, where the problem arose as a whole by representatives of different disciplines working collabratively. Thus, the use of the concept «interdisciplinary» in Systems Approach is a matter of how scientific inquiry is to be conducted.

Methodological Aspects : von Bertalanffy [6] says that «..... (G.S.T.) is a hypothetico-deductive system of those principles..... p. 304». This means that the methodology of G.S.T. is deductive, and the hypothetico-deductive system is seen as if it were a theory to explain disciplinary theories. Thus, experimentation in G.S.T. is removed. On the other hand, Systems Approach is a real systems reseach. It studies the systems and establishes its own theory. Therefore the Systems Approach produces both theoritical and emprical knowledge of systems. Accordingly, experimentation is included in Systems Approach.

General Systems Theory tries to find similarities in various scientific disciplines by analyzing their theories and tries to find out principles applicaple to all systems, Systems Approach analizes systems wholistically and finds tools and techniques for solving the problems of particular systems.

Interactions :

von Bertalanffy [8] claims that «There are general aspects, correspondences, and isomorphism common to systems. This is the domain of G.S.T. p. 415». Since Systems Approach deals with problems of systems which are in the domain of G.S.T., when G.S.T. explores some principles applicaple to all systems, then Systems Approach takes into account all those principles, In other words Systems Approach may benefit from G.S.T., whatever it develops.

G.S.T. brought, besides many others, the concept of «open systems» into the picture. As Ackoff [2] says «Research can seldom be played with a single concept; a matched set is usually required. ..... A scientific field can arise only on the base of system of concepts ..... p. 671». That is, the concept of «open systems» leads to a new approach to the problems of organizations». Katz and Kahn [12] call this as «Open - Systems Approach to Organizations». They say «The Open - Systems Approach begins by identifying ..... p. 103.». This concept is used instead of Systems

Approach; which also considers the System from which the problem arose as an open system. In any case, these concepts make the human being, which is the main element of man-machine systems, open-minded.

Conslusions :

The main results obtained in the above discussions may be summarized as follows :

— Both G.S.T. and Systems Approach can be considered as the end-products of the Machine-Age.

— Both are based on the concepts of wholeness, organization, teleology and etc., and based on the synthetic (or systems) mode of thought.

— Both theories are interdisciplinary and willing to optimize the use of resources. They both benefit from other theories and whatever they have developed.

— G.S.T. is a pure science while Systems Approach is an applied science.

— The methodology of G.S.T. is deductive. i.e. experimentation is removed. In the case of Systems Approach, experimentation is included.

— Both General Systems Theory and Systems Approach may benefit from each other.

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