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WHAT IS THE SYSTEMS APPROACH?

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The term "Systems Approach" has appeared frequently in management and systems literature recently. In spite of its popular use, its meaning is seldom clearly defined. Even when and where a definition is given, there is little agreement as to exactly what it means. The confusion seems to stem from the fact that a "system" often means different things to different people. To an engineer it may mean a physical object. To an economist it may be a mode of operation such as the free enterprise system or an inventory system. To a computer scientist it may mean either the hardware system of the computer or the software programs or information systems. Thus, the term has become so generic that it is almost meaningless. The purpose of this paper is to develop a concept and definition of the systems approach as a methodology for solving problems.

What then do we mean by the "Systems Approach?"

Churchman uses the familiar fable about several blindmen each touching a different part of an elephant to illustrate his concept of systems. The moral of the story is that when confronted with a problem one should not just look at a part of it but should, instead, view the whole picture which may be referred to as the total systems concept.

Such a concept certainly has its appeals, especially in the elephant case. However, it also raises some important conceptual and methodological questions. For example, how are we to know we are not dealing with the whole problem and not just a part of it, since in many respects our perception is limited to what we can sense and perceive? In fact, the blindmen and elephant syndrome is all the more prevalent and evident these days as the problems are becoming more and more complex. Take the drug problem, for example: how many different views are there concerning this wide-spread social ill? The law enforcement officers can give us one answer and the sociologists, another. The psychologists may have a theory for it, and the medical researchers can cite a few more case histories. Even among the experts themselves in the same field, their opinions may differ widely. Unlike the elephant problem, drug addiction is the type of problem where no one knows what kind of monster it really is. Maybe all of the experts' opinions are nothing more than the blindmen's interpretation of the elephant after all.

The second question relevant to the total systems concept is: "If a problem is to be considered in whole and not in part, what constitutes a whole and what does not?" Not all problems are as clear cut as that of describing an elephant whose total picture is at least visible and identifiable. Most of the problems, especially those involving social, economic, and political behavior, elude such identification. Consider the traffic problem, for example: how should we view it in terms of a whole system? Should we take into consideration such factors as the pedestrians, the sizes, shapes, or noise levels of vehicles, etc.? Where should we draw the line? Furthermore, since every system is a subsystem of a larger system, how far should the system boundary be drawn? For example, it has been said in the marketing field that had the buggy whip manufacturers realized that they were in transportation business instead of buggy whip business they probably would have survived today. This is akin to the total system viewpoint. Plausible as it may sound, the concept cannot be stretched too far, however, without rendering itself meaningless. What if, for example, the buggy whip business were regarded as in *a* business, period, instead of in any particular business; would this broader, all-inclusive concept have helped the industry solve its problems? Obviously, the answer to the question depends not so much on the type of business it was in as to how it viewed and defined its problems. If the industry had insisted on viewing its declining business as a marketing problem by directing its efforts on promoting sales in a decaying market, it should not have been surprised to find itself losing out in the end. On the other hand, if it was aware that the falling demand for buggy whips was a natural consequence of changing technology, it would have defined the problem in those terms and coped with it as such.

The preceding illustration suggests that in problem-solving the crucial question is not just whether we are dealing with the total system or where we draw the system boundary, but what proper entities and attributes of the system should be. In other words, the important question is whether or not we have identified the right problem. To illustrate how a problem can be solved readily if it is properly identified and defined, the following examples may give further illumination.

In his recent book, Rudwick cites a case involving a problem in a new office building. The building has forty stories and is equipped with four elevators serving all forty floors. Opened only a few months, complaints began pouring into the building superintendent's office alleging that it took too long to wait for the elevator on the first floor during the morning rush hour. This would have ordinarily been viewed as a classical queuing problem in management science and treated as such. In fact, several attempts were made to reduce the waiting time. First, a readjustment was made to the automatic control device to expedite the elevators. When that did not improve the matter much, an operator was assigned to regulate the elevators manually in the morning. This proved to be unsatisfactory also. Finally the elevator manufacturer was called in to investigate the problem. After analyzing the situation, the manufacturer's engineers suggested several alternative solutions. One was to replace the existing control device with a more complex one having more flexible features such as directing some cars for expresses and some for local stops. This was estimated to cost about $7,000. Another alternative was to add another elevator to be installed outside of the building with a glass enclosure which provides the riders with an outside view and the building with an advertising effect. This would cost about $50,000. While the building management was debating the pros and cons of these proposals, some one came up with an ingenious idea that solved the problem at a cost of only $300. How was this done? Actually the solution was quite simple. It was the installation of a television set in the lobby near the elevator so that the riders could watch the program while waiting for the elevator to return to the first floor. The riders were no longer impatient with long waiting and complaints subsided.

Now what lesson can one learn from such an experience? An obvious one is that how and how well a problem is solved depends entirely upon how and how well it is defined. When the elevator case was viewed as an elevator delay problem, attempts to solve the problem tended to focus on the reduction of the delay time. But when it was defined as a problem of boredom from waiting, the solution was simply to ease the boredom.

The example also helps to demonstrate that in problem-solving it is neither necessary nor sufficient to look at the total picture but is essential to locate the key issues underlying the problem which may be obscured from the surface of the problem or may lie beyond its obvious and immediate realms. Perhaps the elephant story is not too farfetched after all had it been casted in a different light, say, having the blindmen describe the skin of the elephant. They would likely have provided the correct answers.

The "Systems Approach", in short then, is essentially a way of perceiving and thinking through a problem by identifying and focusing on the critical elements pertaining thereto. In other words, in order to apply systems approach we need to know about the nature of the problem and what kind of problem we are dealing with first. But what is a problem? And how can it be identified?

From a systems point of view, a problem may be defined as the deviation of the actual from the desired state of affairs at a given point of time. It can be defined as follows:

$$P_t = |D_t - A_t|$$

Where P_t = Problem at time t

D_t = Desired state of affairs at time t

A_t = Actual state of affairs at time t

t = A point in time

By this definition and given an equilibrium position between D_t and A_t a problem i.e. $P_t > 0$ can exist if and only if any of the following conditions exists.

a) The actual state remains the same, but the desired state has changed, i.e. $D_t \neq D_{t-1}$ given $A_t = A_{t-1} = D_{t-1}$. This is a *goal changing problem* and shall be identified here as a Type I problem.

b) The desired state remains the same, but the actual state has changed; i.e. $A_t \neq A_{t-1}$ given $D_t = D_{t-1} = A_{t-1}$. This is a *goal seeking problem* and is to be identified as a Type II problem.

c) Both the desired and the actual states have changed *to different positions,* i.e. $D_t \neq D_{t-1}$ and $A_t \neq A_{t-1}$ given $D_t \neq A_t$ and $D_{t-1} = A_{t-1}$. This is a goal changing as well as a goal seeking problem occuring at the same time and is to be called a Type III problem.

Why this classification? How is it going to help identify and solve problems? Before answering these questions let us first examine the difference in characteristics between the two basic types of problems, namely, the Type I and Type II problems.

As stated earlier, Type I problems are essentially *goal changing* problems and Type II problems are *goal seeking* problems. Therefore, the objectives and purposes of the two are entirely different. For example, when an organization is contemplating entering a new market, it is faced with a goal changing, Type I, problem. But if it is attempting to regain a declining market share, it is dealing with a goal seeking Type II problem. The former case may be regarded as a preventive or anticipative process, and the latter, as a corrective or remedial action.

In terms of the systems concept, the former may be viewed as a problem of systems design and synthesis, the latter, of systems analysis and maintenance. The former involves systems prognosis with emphasis on systems planning and forecasting, while the latter involves systems diagnosis with emphasis on systems guidance and control. Thus, the former assumes a leadership role that is capable of learning, creating, leading, and initiating an action; while the latter merely follows the direction and path of a predetermined goal and destination and is to take corrective action only when a deviation occurs. In terms of systems hierarchy, the former is a system of the highest order in which being human plays a dominant role, and the latter belongs to a lower order system which can often now routinely be handled by computers or other mechanical means.

Having defined problems in terms of the systems concept and having delineated their characteristics, we are now in a position to apply the systems approach toward solving these problems. Since the two major types of problems have different objectives and characteristics and are systems of different hierarchies, the approaches to their solution, of necessity, also take different forms.

The systems approach to Type I problems starts with a clear definition of the new desired state or goal as opposed to the old one from which it has changed. In defining the new desired state, all relevant dimensions such as what, where, when, who, and how much need to be specified. For example, if a firm is interested in entering a new market, it must specify what product or service is to be introduced in which area at what time, who will be its target customers, and how many are expected, etc.

Once the new goal is defined, it should be analyzed, questioned, and challenged. This is the dimension of "why". Any new desired state that fails to meet or is weakened by the challenge has a questionable value and should be reconsidered or redefined. In defining the new desired state, it is important to define *what is*, as well as *what is not* the desired state. Doing so will help delineate what is a problem and what is not, and draw a clear system boundary and rule out irrelevant considerations. It should be noted that defining a desired state is *not* defining a problem. But defining the difference between the new desired state and the actual or existing state *is* defining the problem. How a problem is to be solved depends upon not only how the problem is defined but also upon how the desired state is defined.

Any new desired state, before it can be achieved, is always surrounded by all sorts of constraints or obstacles. These constraints may be of a resource, technological, environmental, natural or even artificial nature. Therefore, one of the important tasks in the systems approach is the assessment of all conceivable constraints. This often takes the form of a feasibility study or a pilot test project, etc. Some constraints can be avoided or removed by alternative system designs or by trade offs. Some constraints are logically impossible to avoid or remove. For example, it is logically impossible to get both a head and a tail with one toss of a coin. In such cases, the new desired state is unfeasible.

Once a new desired state is defined and deemed feasible and once a problem is well defined, it should be followed by a simplification process. One of the contributions that the systems approach makes in problem-solving is its emphasis on the various techniques and methodologies it has developed for system simplification. The process may involve the simplification of the new desired state, the simplification or removal of constraints, or the simplification of the problem itself.

Having defined the new desired state, its difference from the actual state, and the constraints, the task of the systems approach is to find ways and means of removing or reducing the difference. This is an alternative generating process. There are many ways of generating alternatives, among them are such methods as creative inquisition, logical extension, dimensional scanning, pattern recognition and search combinational analysis, cumulative experiments and learning, computer simulation and modelling, etc. The details are too numerous and beyond the scope of this paper.

The alternatives once generated must be evaluated according to a given set of criteria and orders of priorities. A number of methods have been developed to evaluate and prioritize alternatives, among them are such techniques as decision analysis, cost-benefit, and cost-effectiveness analyses, etc. It must be noted, however, because of the individual preferences of different decision makers, the final selection of the alternatives may or may not be consistent with the new desired state originally prescribed. In such cases, the solutions to the problems may simply be a compromise instead of an optimal or rational one.

The approach to Type II problems assumes that a desired state is already in existence or well established; the problem is to diagnose the cause of the actual state deviating from it and to find remedies. Thus, a Type II problem begins with a symptom. There are certain conditions which must be satisfied before a symptom can be detected. For example:

a) A symptom must be observable and measurable.

b) Its detection requires the aid of an information system; namely, a memory, a sensor, a measuring system, a comparator, and an output system.

c) The absence of a signal can be the presence of a sympton.

d) The location of the sympton may be totally unrelated to the location of the problem.

Various techniques and methods are available for detecting certain types of symptoms. The medical profession has the most advanced symptom detection techniques and devices. Management Science has in recent decades developed some powerful tools and techniques in handling large and complex problems, but still largely relies upon experience, insights, and intuition to locate problems. Behavorial scientists have recently experimented with various techniques to predict or modify human behavior, but there are still reservations limiting their wide applications. There are encouraging signs that more advanced management information systems are making great headway, and may now be possible for management to receive early warning signals before a problem erupts.

Even with the early warning signs available to management, it is still ill-equipped in diagnosing the cause of the problem. Diagnosis is a process of relating the symptom to the causes. For example, in the elevator case cited earlier, the riders' complaints (symptom) were being diagnosed as an elevator delay problem (wrong diagnosis) instead of a boredom-from-waiting problem (real cause). For every elevator problem which finds a correct solution, there must be hundreds of others which do not. Thus, the diagnostic process presents a continuing challenge to which future research in the systems approach should be directed. In the Type II situation, once the difficult task of diagnosing the problem is accomplished, the rest of the approach is comparable to the one used for solving Type I problem, namely, generating, selecting, and implementing alternatives and follow ups.

The preceding pages are a brief overview of the Systems Approach. It offers a logical and consistent definition as an aid to problem-solving. No claim is made of its completeness or uniqueness. Hopefully, it helps contribute toward a better understanding of the complex human problem solving process. In summary then, the systems approach to problem solving is a way of thinking through a problem depending upon the nature and the type of problems to be handled. It takes a system synthesis and prognostic approach if the problem is of the goal changing nature and uses systems analysis and diagnostic approach if it is a goal seeking problem. It specifies as well as classifies, analyzes as well as synthesizes. It is interested not only in "What is?" but also in "What is not?"

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