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Engineers think of themselves as problem solvers. Give them a problem: for example, tell them to take us to the moon, and they will oblige you. But whether we should go to the moon or not is not of much concern to them. Thus, while *solving* problems fascinates them, problem *perception* and problem *formulation* do not. But to solve a problem, first we must perceive it. Perceiving is not enough; we must proceed to formulate it. That is we must cast it in a language that enables us to use our available intellectual and cognitive tools to solve, resolve or dissolve it.

Perceiving a problem is analogous to what Gestalt psychologists think of separation of a figure from its background. If I show you a picture of an ashtray placed on a table, you can identify it as an ashtray only if you know about practices and convention of smoking. Identifying the picture of the same ashtray on a Martian landscape is not that easy. You need to know much more than the convention of smoking to identify it as an ashtray. As far as you know, it can be a flying saucer! Thus, recognizing an ashtray is not a simple task. You need to know a lot about many things. This explains why an act of perceiving a problem is a multi-disciplinary, inter-disciplinary, and ultimately a system activity. The ashtray obtains its meaning in the context of the constructed system that you have assumed is embedding it.

The same is true for problem formulation. To articulate a problem in a language that allows us to apply effective methodology to solve it, requires that we know about available methodologies. Academic disciplines provide disciplinary toolboxes that are useful in a narrow range of circumstances. For example if we are encountering a water shortage and ask a civil engineer for advice, very likely the solution that will be offered will be to construct a dam or a piping system. An economist very often would suggest price manipulation. While a city planner will be disposed toward rationing. Someone has said that if the only tool that you have is a hammer, the world appears to you to be full of nails. Again you need multidisciplinary, inter-disciplinary and ultimately a system tool box.

We are solving a “right” problem if by solving it we are closer to our goal. Otherwise we are solving a “wrong” problem. Whether we choose to solve a right problem or a wrong problem is decided at the problem perception and formulation levels. Once we are engaged in solving a problem, questioning whether it is a right or a wrong problem is not an option.

Since it is by far better to solve approximately and crudely a right problem than to solve accurately and precisely a wrong problem, perceiving and formulating problems are by far more important to decision making process than solving those problems. People who make the decision what problems need to be solved always rule the technicians who solve the problems that someone else has decided needs to be solved. The higher rewards that

society bestows on managers, politicians, and moneymen over the technicians is in recognition of the above reality.

Since system approach is *sine qua non* to problem perception and problem formulation, naturally system thinking has been more influential in the world of business than the world of engineering where most attention is paid to solving problems

In problem solving phase, system approach in its current state of development plays a secondary role. One can build a bridge or cure a disease or for that matter create a smart computer without explicit contribution of what we call system approach - albeit more expensively and perhaps inefficiently. Once you decided to build a concrete bridge, you need a concrete engineer and not that much a system engineer. This is not to say that system thinking is not useful in problem solution - it is. It can contribute to optimize any undertaking. The point is that at the current stage of development of system science, where we still lack formal analytical-synthesis system tools, the engineers are not seriously dependent to system toolboxes for conducting their profession. This is clearly apparent from examination of curriculum and research in engineering schools in the country. In words of one of our colleague in the Department of Bio-engineering: "system thinking is not important, molecular biology is." Of course, he was just referring to the field of bioengineering and not all engineering. However, you ask any of our colleagues in any engineering department and you will hear the same response substituting molecular biology with some other substantive field, say fluid mechanics or transport phenomena, etc.

Although, in last several decades much effort has been extended to bring into the engineers' view the importance of system approach and despite the fact that engineers are now well disposed to acknowledge the importance of system mindset to design, except in some narrow fields, they simply do not have the tools to deal with such ideas. The result is that the most important decisions regarding engineering projects are usually left outside of engineering.

Engineers are concerned with objects and phenomena in which both human purposes and natural law are important. Current engineering practice however, keeps these two disparate components separate. It deals with natural law in the language of mathematics and for most parts lets other professions deal with purposes and values. The profession simply does not know how to formulate the phenomenon of purpose and values in mathematical/engineering language. Unless this state of affair changes I venture to say that system approach will always remain a service field in engineering profession.

Is there a possibility of change? Although, it is hard to see the future, some encouraging developments are taking place that I believe should be the center of attention of an organization that aspires to be a leader in the field of system engineering. The progress is taking place in both ends of the spectrum. On one end scholars are exploring the relation between molecular structure of systems and their emerging properties. On the other end they are developing tools of modeling the emerging properties from exemplars of the behavior of the system under study.

Some years ago, Herbert Simon made the observation that in very many cases whether a particular system will achieve a particular goal or adaptation depends on only a few characteristics of the outer environment and not at all on the detail of that environment. In different forms this has been the basis of attempts in many different fields to employ the notions of Adaptive Agents. These diverse fields include linguistics, artificial intelligence, natural evolution, economics, biological arms races, the Prisoner's Dilemma game in political science, two-armed Bandits in operations research; antigen-antibody matching in immunology, etc.

The most promising of these works is the contribution of John Holland and his co-workers in Santa Fe Institute. Using the possibility of representing the system and its environment in digital notation and employing the tools of genetic algorithm, John is attempting to construct a rigorous mathematical system that connects the emerging property of the system with the characteristics of its components. His model, Echo is already showing interesting properties such as showing the emergence of order from a random beginning.

As a side, engineers already use this technique in strictly technological domain. For example, they can predict the behavior of a very complex oil refinery from the properties of its components with good deal of realism. What they cannot do is to internalize human purposes and values in their design.

The other line of research is attempt to construct an inductive engine that takes as input, examples of the behavior of the system and learns to behave in the image of that system. These attempts which collectively are known as Artificial Neural Networks promise to be useful tool of design where the system under consideration is complex adaptive systems and theories of their performance is lacking.

While many are searching to invent intelligent machines, others are looking to develop intelligent methodologies that can mimic learning capability and adaptation properties of complex systems. System approach will benefit from these attempts. These lines of works need to be encouraged. In conclusion, to make system approach attractive to engineers, it is necessary that a formal language be developed. In the absence of such a language lip service will be given but practice will be as usual.