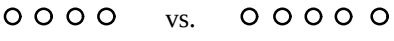
So, what's System[s] Thinking

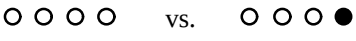
by Ian Bradbury

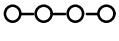
System[s] thinking is an area that has attracted quite a lot of attention in recent years. This brief article seeks to introduce the first of two key ideas in system[s] thinking, relate it to popular writings on the subject and illustrate the concept. (the second part, originally published as a second article, is included below)

Interdependence

Ludwig von Bertalanffy said that in dealing with complexes of elements, three different kinds of distinction may be made: 1) According to their *number*, 2) According to their *species* and 3) According to the *relations* of elements.

1.  vs.

2.  vs.

3.  vs. 

In cases 1 and 2, the complex may be understood as the sum of elements considered in isolation. In case 3, not only the elements, but also the relationships between them need to be known for the complex to be understood. Characteristics of the first kind are called *summative*, of the second kind *constitutive*. Complexes that are constitutive in nature are what is meant by the old phrase *"The whole is more than the sum of the parts."*

An example of cases 1 and 2 might be the value of the change in your pocket. The value of the change taken altogether is obtained by simply summing up the values of the individual coins taken separately. An example of case 3, used frequently by Russell Ackoff to illustrate a constitutive complex, is a car [or truck if preferred]. If we consider what the value of the vehicle is, it is in the functions that it performs for us such as personal transportation, transportation of goods, status and so on. The value of the components that make up the car such as doors, tires, seats, etc. have no meaning independent of the other components with which they have to work. The value of any component is not in the component itself, but in how well it works with the other components that make up the car. Ackoff illustrates this point by asking people to imagine that a group of engineers has been collected and asked to vote on which door, seat, engine, etc. is world class -- the best there is. If the world class components were then collected together and we were to assemble them into a vehicle, the result would be far from world class -- it would not even serve the vehicle's basic functions since the components would not fit together.

The concept of interdependence is fundamental to Ackoff's definition of a system as a set of parts [elements] for which:

1. Each can affect the essential defining function, behavior or property of the whole.
2. The way each can affect the whole depends on what at least one other part is doing; that is, no part has an independent effect on the whole.

3. Every possible subgroup of these parts can effect the essential defining function, behavior or property of the whole, but none can have an independent effect on it.

Hence the essential defining function, behavior or property of a system for Ackoff is a function, behavior or property of the whole that none of its parts displays. Ackoff further differentiates systems into three classes:

1. *Mechanistic* systems which serve a function, but have no [human] purpose, and whose parts have no purpose;
2. *Biological* systems which have a [human] purpose, but whose parts have no purpose; and
3. *Social* systems which have a [human] purpose and whose parts have [human] purposes.

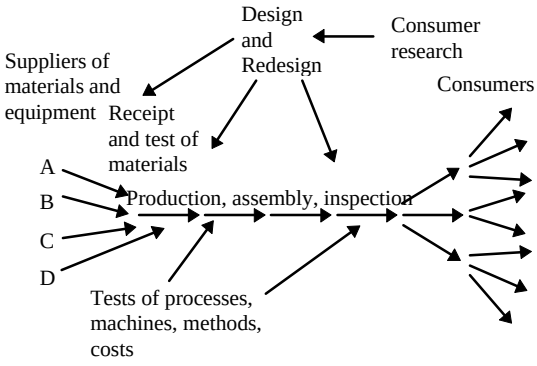
Examples of these three types of system are:

1. A vehicle -- serves functions such as providing transportation, but has no purpose in and of itself.
2. A human -- has personal [human] purposes, but its organs do not have purposes, just functions serving the higher human purpose.
3. A business -- has purpose in terms of the human needs that it serves, and has components with purposes, for example the personal purposes of its employees.

W. Edwards Deming includes *Appreciation for a System* as one of the four interdependent components of his core theory. In this he states that:

- A system is an interconnected complex of functionally-related components that work together to try to accomplish the aim of the system.
- A system must have an aim. Without an aim, there is no system. and
- The aim [for man-made systems] is a value judgment

Deming is, in Ackoff's terms, restricting his use of the term system to mean social system. Deming provides a view of production as a system that he shared with the Japanese in 1950:



Embedded in this process model of a business is an interdependent view of work performed in each of the represented areas toward the aim of the system. The aim provides the nature of the interdependence, as well as boundaries of the system.

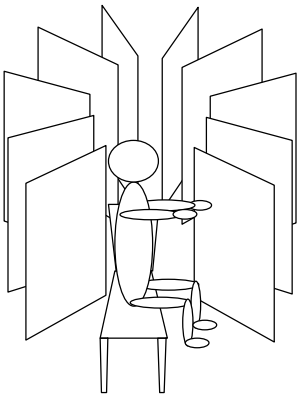
Key to improvement of performance of a system is understanding that the leverage is not in improving its elements, per se, but rather in improving how they work together -- their interactions. A good example is design for manufacturability where one considers how a design may be made which 'fits' well with the capability to manufacture.

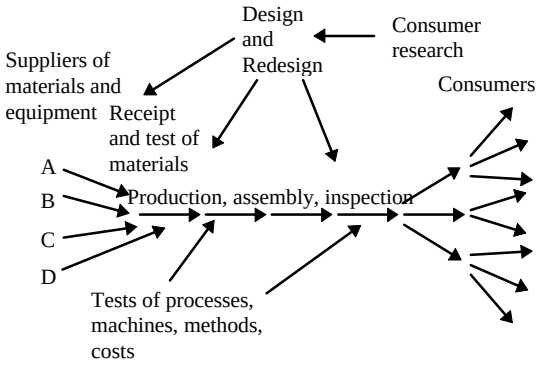
The second key concept, which will be covered in a forthcoming issue, is that of *cause and effect being separated in space and time*.

So, what's System[s] Thinking (part II)

This article covers the second of two key ideas in system[s] thinking. As before, the intent is to relate it to popular writings on the subject and provide illustrations of the concept.

Separation of Cause and Effect in Space and Time





Production Viewed as a System. The New Economics

I first saw the figure on the above left used by Mike Beck as a humorous way of illustrating the concept of cause and effect being separated in space and time. The person in the seat, feeling crowded in, is *proactively* pushing away the *problem.* In due time the downstream consequences will be felt, although the person in the seat at that time may not be the current resident! In this particular example, the effect is separated in time from the cause, but not in space.

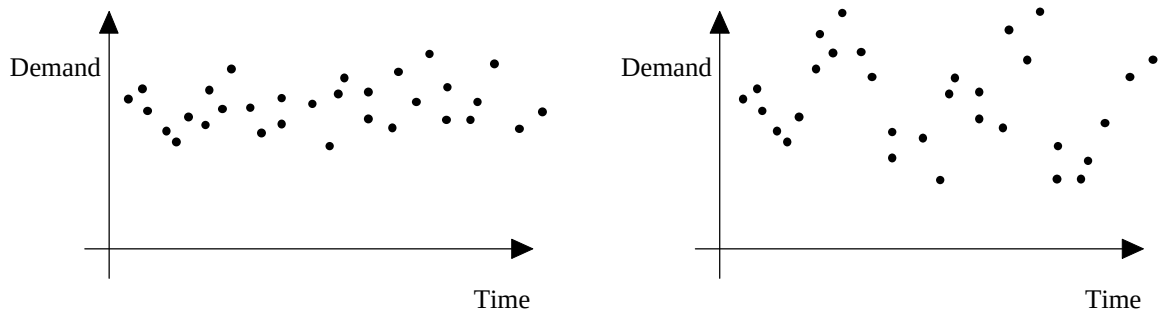
In the last article W. Edwards Deming's *Production Viewed as a System* was discussed from the perspective of the interdependency of components of a system in accomplishing the system's given aim. This graphic may also be used to illustrate the concept of cause and effect being separated in space and time. It is evident, for instance, that actions taken in the design of a new product will have many 'downstream' consequences such as ease of manufacturability, serviceability, fitness for intended use and so on. We might thus consider the quality of a design, from a systemic perspective, to be the degree of fit with customer needs. This relates to fit with the company's capability to manufacture the product and provide related services to the extent that customer needs are better met (including cost of use).

Gipsie Ranney provided a real illustration of the separation in time and space of actions taken by a marketing group in a company, in this case sales promotions, and the resultant variation in demand for a product that would otherwise have had quite stable demand. The graphics below illustrate the contrast. In the case illustrated, 'lackluster sales' was viewed as a marketing problem and the solution taken was to introduce sales incentives for a limited time. Since this did indeed result in an immediate increase in sales, the program was judged a success by the marketing department. Some time later, sales were noted to be well below the desired standard so the obvious solution, one found to be effective in the past, was again taken by the marketing group. As before, sales increased and the promotion was again judged to be successful. This practice continued over time with the performance of the marketing group being judged as very good by the Corporation.

The conclusions of the marketing group regarding the effects of the sales incentives were correct over the short time period where sales results were compared. The larger dynamic, however, was that the underlying

demand for the product was essentially stable so that the temporary increase in sales that resulted from incentives was due to people buying more than they needed and storing the product for future use. As a result sales following the incentives dropped below their natural level while people used up their stored product. People also learned to wait for sales incentives. The net result was the same long run average demand, but with much greater variation. A similar customer dynamic may be observed with timing of larger purchases such as vehicles. The manufacturing and distribution system has to accommodate this variation and in doing so reduces the value of the product - either by increasing cost or negatively impacting availability. Typical methods for coping with such variation are over-capacitization, layoffs and overtime, inventory and variation in time to delivery or product availability. As a result of this the company was becoming progressively less cost competitive on the product in question.

Happily the marketing and production people got together and realized the nature of this dynamic. The sales incentives were dropped and replaced by everyday value pricing and as a result variation in product demand was considerably reduced. The time and effort that was being spent on trying to deal with the extreme variation in demand was redirected to improvement of productive capability which resulted in improved quality and reduced cost. The marketing department also redirected its efforts to trying to improve the level of demand in a sustained fashion through education of customers in ways that the product might otherwise be used.



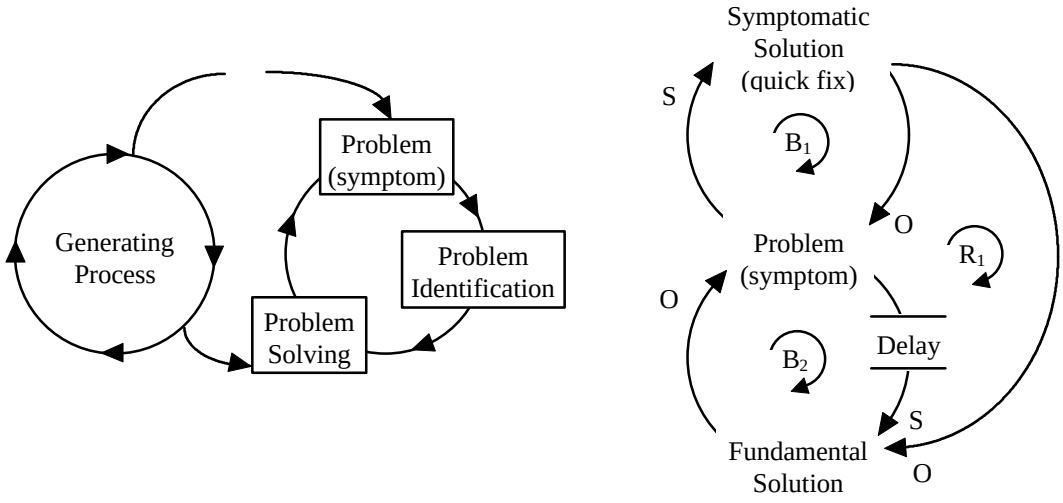
Without sales promotions

With sales promotions

In chapter 3 of *The New Economics*, W. Edwards Deming illustrated the concept with the following:

> **Delayed effects.** The effect of a movement by management made now may not take effect till many months have passed, even years. The immediate effect may be nigh zero, or even negative. Interpretation of the change could thus be illusive.
>
> > A simple example is training. The only immediate evidence is its cost, expense. The effect of training will not be realized for months or even years in the future. Moreover, the effect cannot be measured.
> >
> > Then why does a company spend money for training? Because the management believe that there will in the future be benefits that far outweigh the cost. In other words, the management are guided by theory, not by figures. They are wise.
>
> An unstudied solution to a problem may yield immediate results in the right direction, yet in time bring disaster. For example, to sack people lowers costs straight-away, but in due time may cause serious consequences. The benefits of a fundamental solution may not show up for a long time.

Dr. Deming goes on to reference a diagram from *The Fifth Discipline* by Peter Senge, a version of which is illustrated on the left below. It is a particular case of the *Shifting the Burden* system archetype shown to its right.



The archetypes introduced in *The Fifth Discipline* are a language for talking about frequently recurring dynamic structures underlying the actions we take. In the *shifting the burden* archetype two solutions are displayed to a given problem. The upper loop, B_1, represents the 'quick fix' approach to solving the problem, which may be thought of as taking the kind of action that makes the symptom quickly go away. At a personal level, an example of this would be taking a pain killer to address the problem (symptom) of pain. The lower loop, B2, represents taking action on the fundamental cause of the problem that we are observing. This contains a delay since the diagnosis of the fundamental cause of a problem required for a fundamental solution is typically more difficult than just treating the symptom. It is also often the case that action on the fundamental cause may entail a longer delay before symptomatic relief occurs. The loop on the right, R1, represents a disturbing aspect of this archetype - that just taking the quick fix approach often results in more problems in the long run. This occurs for a variety of reasons. One is that energy being expended on the symptomatic solution is not being expended on the fundamental solution - this is shown in the figure on the left as resources being drawn away from working on the generating process to work on solving problems downstream.

An example that is illustrative considers the relationship between new product development and current product problem solving: If people are pulled away from working on the development of future products to solve the problems with the products of today, we may compromise the development of future products, increasing the likelihood of the future product's having problems. Since pulling people away from future programs has been seen to be effective in problems being solved in the past, it is addictively tempting to react to the present problems in the same manner. Such action may even be termed as being *proactive* with today's problems, but is seen to be a form of reaction from the perspective of the system archetype.

Another example that may be instructive to view in the framework of this archetype is a Preventive Maintenance Action Strategy. If the problem is taken to be breakdown of machines, a quick fix would be to rush to fix the machines as they break down. A more fundamental solution may be to have scheduled preventive maintenance (or take action on other relevant causes of machine reliability, such as procurement and setup practices). It is easy to see how one can get caught in the addictive loop of repairing the machines as they break down - low productivity due to machine breakdowns generates a high degree of urgency behind ensuring the machines are up and running again quickly which draws resources away from preventive maintenance to quickly fix those that have unexpectedly broken down which increases the likelihood of unexpected breakdowns in the future, further lowering productivity. Not only is it unfortunate that the quick fix approach has this addictive, self-reinforcing nature, but the fundamental solution approach generally involves things getting worse before they get better. This is a consequence of the delay

in the loop B2. It may be at the heart of the difficulty of sustained application of approaches such as preventive maintenance, since one has to both break with the addictive cycle of quick fix as well as keeping the faith as things get initially worse prior to the state of sustained higher performance.