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Research Note

The SOP Model of Change as a New Way of Looking at Causality

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This research note sets out a multi-faceted view of causality referred to as the structure-organization-process (SOP) model of change. The SOP model is an ontological schema that can be utilized wherever order can be found. A case study on the periodic table and the structure of DNA provide the first insight that the model might be a general organizing principle. More case studies are required to evaluate the applicability of the SOP model.

Keywords causality; SOP model; general organizing principle

INTRODUCTION

Simple cause-effect ($c > e$) statements explain only simple phenomenon. The post-Newtonian world is complex; the world is filled with reversible and irreversible phenomena. Prigogine and Stengers (1984: p. 10) state: 'on every scale self-organization, complexity and time play a new and unexpected role'.

Causality theorists appear to ignore the emerging science by clinging to a Newtonian view where $c > e$ persists. Consequently, little has emerged by way of novel ideas on causality. Instead, causal theorists focus their attention on defining 'cause' and its various 'conditions'. Kim (1999, p. 125) and Lakoff and Johnson (1999, p. 206) have grave concerns that a single view of causality is possible.

It is generally agreed that the sciences are converging and the hunt appears to be for a theory of everything (Barrow, 1991). Systems theorists have paid little attention to causality; tending to direct their attention to empirical phenomena rather than metaphysics. Capra (1996: p. 156), building on the work of Maturana and Varela (1987), is the exception. Capra argues that there are three key criteria for describing a living system:

- the pattern of organization: the configuration of relationships that determines the system's essential characteristics (e.g., autopoiesis);
- the structure: the physical embodiment of the systems pattern of organization (e.g., dissipative structures); and
- the life process: the activity involved in the continual embodiment of the system's pattern of organization (e.g., cognition).

However, Capra limits his criteria to living systems. Also, there has been little-to-no development

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of these ideas since they were first mooted by Capra, nor any thought given to how these criteria might relate to any system; living or otherwise. In 2007, Glassop (2007) paid specific attention to Capra's general criteria to develop his views into a multi-faceted theoretical model for causality.

THE SOP MODEL OF CHANGE

The integrative framework developed by Glassop (2007) is called the SOP model of change (Figure 1). The SOP model is derived from the notion that structures (S) are organized (O) by processes (P) (Capra, 1996, p. 156). The concept of SOP is relevant to any real thing, at any level of analysis. Structures (S) are inputs that might be causes (*c*), the process (P) is an interaction event (>), and effects (*e*) are the outcomes that have been organized (O) by the causal event (P) (an ontological schema).

Firstly, the SOP model contends that real things have an intrinsic multi-faceted arrangement (attributes, parts and whole). This proposal integrates ideas from Weismann (2000) about attributes, Maturana and Varela (1987) about parts and physicists about wholes existing in four-dimensional spacetime (Hawking, 2001). Attributes represent the structural components of a real thing, parts represent the organization and wholes come about by a process. The notion of SOP continues at all levels of analysis.

Secondly, the SOP model treats a causal event as a process, where inputs (real things) interact to yield outputs (effects). This is a systems theory approach (Zaiger-Roberts, 1994, p. 28) or what Hall (2004, p. 225) refers to as 'production causality' (where the cause produces the effect). However, unlike Zaiger-Roberts (1994) and Hall (2004), the concept of causality proposed only allows two real things (equal but opposite inputs: force and matter) in a causal event.[1] This view of a causal event may appear Newtonian (where force causes effects), but when it is coupled with a multi-faceted view of real things (inputs) an array of different effects become apparent.

The SOP model rests on the simple premise that multi-faceted real things interact to generate multi-faceted real things (as effects). On this basis, it is necessary to examine a causal event in terms of what occurs when attributes interact, when parts interact and when wholes interact. The description of change that emerges from this examination reveals the diversity of real things that flow (as effects) from a causal event:

- four individual effects emerge when attributes interact (referred to as structural change),
- twelve categorical effects emerge when parts interact (referred to as organizational change), and
- three universal effects emerge when wholes interact (referred to as processual change).

The novelty of the SOP model resides in the multi-faceted approach to a causal event. The new conceptual framework offered by the SOP model integrates conceptions of reality (P), causality ($\rightarrow$) and ontological schemas (e): real things (ontology) interact (causality) to yield a diversity of real things (ontological schema). For example, a rock (P_f) and a glass window (P_m) interact ($\rightarrow$) to yield pieces of glass (e) (Figure 1). The integrative framework of the SOP model offers a resolution to a linear cause-effect approach.

THE SOP ONTOLOGICAL SCHEMA

Of special interest in the SOP model is the ontological schema. The effects that ensue from a multi-faceted causal event give rise to individual

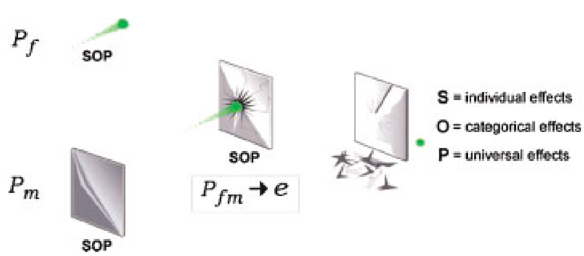

Figure 1 The SOP model of a causal event

[1]The SOP model contends that real things are not a priori force or matter; that force and matter are states that any real thing might take during a causal event. For example, when I stub my toe against a rock, the rock is being forceful and not relinquishing its spacetime location thereby forcing my toe to squash up. However, an earthquake forces rocks (as matter) to spill out from the mountain top.

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effects (new individuals; e.g., a human infant), categorical effects (categories of things; e.g., marriage gives rise to a new family where multiple individuals are categorized as a family) and universal effects (brand new categories of things; e.g., dinosaurs). Categorical effects ensure that things that have the same property set do indeed belong to the same category. In this regard, all individuals within the category must comply with a specific pattern dictated by the property set.

When two things (with a structure and organization) interact there are 12 possible outcomes on three levels (SOP). Thus, the SOP model asserts that there is a maximum of only four kinds within a category; for example, there are four kinds of DNA, four main blood groups, four kinds of fundamental elements, four kinds of multi-celled living things and four fundamental forces in nature (Glassop, 2007).

The four kinds of things that belong to a property set can be described according to four sub-patterns: complimentarity, similarity, chirality and polarity. Each kind of individual that belongs to the property set must be unique, but must belong to each of the four sub-patterns. That is, every real thing can be described according to four variables: complimentarity, similarity, chirality and polarity (for example, the four quantum numbers that describe all elements). The population of a property set can be divided into two across four variables:

- Complimentarity: members of a property set belong to one of the two complimentary pairs: for example, male and female, or the base pairs within DNA. Only complimentary pairs can produce a brand new property set (e.g., chemical compounds, copulation or with DNA creating the double helix from two single strands).
- Similarity: members of a population can fall into one of the two similar pairs; for example, twins can be either dizygotic (fraternal or non-identical) or monozygotic (identical). In DNA nitrogenous bases are either pyrimidines or purines.
- Chirality: there are two primary shapes within a property set; for example, left and right. Chirality sees to the fact that, for example, the left-hand mirrors the right-hand, but is actually different. The right twist and left twist of the double helix are the two chiral categories of DNA.
- Polarity: members of a property set can be oriented in two key directions; for example, north-south, east-west or positive-negative. There are two bonding arrangements in DNA that create a single strand (via opposing similar pairs bonding) and the double strand (via base pairs bonding). An electron in an atom has either positive spin or negative spin.

This view of the SOP model might give rise to the impression that it supports duality theory, where mind is separate to matter. However, the duality noted in the SOP model shows a connection between each part: each sub-category is a pair, and any real thing must belong to one of each of the four sub-pairs.

In summary, every thing has a structure, an organization and comes into existence by a process as proposed by Capra (1996, p. 156). When two things interact (a process) their structure (properties) and organization (property relationships) may alter. The effect of an interaction event generates new individuals (copies of the same thing; e.g., manufacturing a new pair of shoes), new members of a category (e.g., a new variety of plant or a new variety of shoes) or a new category (e.g., a new species or new invention). Membership of a category is limited to the properties of the category; therefore, the pattern (organization) the members (structures) can take is also limited. The SOP model of change asserts that there can only be four different kinds (categories) within a category (property set), and these four kinds can be described by four variables (complimentarity, similarity, chirality, polarity).

A NUMERICAL INTERPRETATION

The numerical interpretation of the SOP model does not provide a set of predictive algorithms, but establishes the governing principles for each kind of change and the relationship between the

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different kinds of change described. It is proposed that:

- structural change (to attributes) is governed by *random* events (level 1), given that the interaction of real things cannot be predicted,[2]
- organizational change (to parts) is governed by *ordered* events (level 2), given that parts are limited within a property set, and
- processual change (to wholes) is governed by *stochastic* events—random within a ordered set—(level 3), given that wholes are comprised of attributes organized into parts.

The first level of the SOP model is *structure*. Structures are indivisible; for example, a human being cannot be divided to get two human beings. There are only four single digit odd numbers (1, 3, 5 and 7); so these numbers represent the structure numbers. The number 9 is a single digit odd number, but it is a composite number because it can be divided into equal segments ($3 \times 3 = 9$), so it cannot be a structure number. Because the structure numbers can only be divided by 1, they represent level one of the SOP model (Figure 2). When the structure numbers are rearranged into two equal pairs (1 and 7, 5 and 3) the result is two equal numbers (8 and 8). The structure numbers are, therefore, ordered as 1, 7, 5 and 3 so that their order is balanced. Balance is an integral aspect of the SOP model given that balance generates stability.

The second level of the SOP model is *organization*. Organizations are divisible; for example a bunch of grapes can be divided into two smaller bunches of grapes. There are only four single digit even numbers (2, 4, 6 and 8); so these numbers represent the organization numbers. Because the organization numbers can be divided equally by 2, they represent level two of the SOP model (Figure 2). When the organization numbers are arranged into two equal pairs (8 and 2, 4 and 6) two equal numbers emerge (10 and 10). The organization numbers are, therefore, ordered as 8, 2, 4 and 6 so that their order is balanced.

[2]Under scientific experiment, interaction might be predicted, but in the natural world interaction is a random affair, ''You can never tell who you are going to bump into!''

9	9	9	9	Level 3
8	2	4	6	Level 2
1	7	5	3	Level 1

Figure 2 The numerical version of the SOP model

Level three of the SOP model is *process*. Process is the relationship between structure and organization: a process organizes structures; for example a manufacturing process organizes various materials (structures) to yield shoes (organization). If the structure numbers (1, 7 5, 3) are set out first and the organization numbers (8, 2, 4, 6) noted directly above, the two rows (or levels) can be summated with each column adding to 9 ($1+8=9$, $7+2=9$, $5+4=9$, and $3+6=9$). Thus, the process numbers are all 9 and represent level three of the SOP model (Figure 2).

There is more logic to the SOP numbers; for example, there is a real relationship between level one and two. For a fuller discussion of the SOP numbers refer to Glassop (2007).

CASE STUDY: THE STRUCTURE OF THE PERIODIC TABLE OF ELEMENTS

The SOP model has been utilized as an analytic device to explore the structure of the Periodic Table. The SOP model is not utilized in any predictive sense; the aim is to determine the merits of the model by examining the relationship between the SOP model and the Periodic Table. The SOP model does not radically change the current structure of the Periodic Table, but it does provide some insight into its pattern. The theoretical analysis offers an explanation for the quantum numbers, the locus of periodicity and some logic for the limit to the kind of elements it is possible to discover. This analysis reveals a new way of looking at the features of the Periodic Table. Of particular interest is the SOP models notion of correlated form as the basis for determining distinctive atomic shapes. A high degree of alignment is apparent between the SOP model and the Periodic Table of Elements. For example, the four blocks of the Periodic Table (s, f, d, p) follow the numbers 1, 7, 5, 3.

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CASE STUDY: THE ORGANIZATION OF DEOXYRIBONUCLEIC ACID (DNA)

Watson and Crick first proposed a description for DNA in 1953. While the nature and workings of DNA have become clearer as interest in genetic research has burgeoned, a theoretical description explaining the distinctive features of DNA has not been presented in the published literature. The SOP model is used as an analytic device to provide a theoretical description for the structure of a nucleotide (the configuration of a nitrogenous base with a sugar and a phosphate group) that forms strands of DNA (chromosomes). The SOP model is able to correctly identify:

- ribonucleic acid and deoxyribonucleic acid as two individual effects,
- the features that describe the nitrogenous bases as categorical effects (complimentary pairs as the base pairs, similar pairs as pyrimidines and purines, chiral pairs as the right and left twist of the helix, polar pairs as the bonding arrangements), and
- a power law for the number of genes per chromosome for *Homo sapiens* as a universal effect.

A theoretical description for DNA may pave the way to understanding the biological locus of chirality (handedness) and the construction of proteins, as a number of authors have suggested.

In summary, the empirical challenge of the SOP model resides in the ability to identify the properties of the property set under examination. However, the author contends that the SOP ontological schema is relevant wherever order can be found. The robustness of the SOP model will only come from its widespread application to different cases. Some of the key areas where the SOP model might be applied and prove useful include: physics, chemistry, biology and psychology.

In physics case studies might include:

- the empirical anomalies noted in the Periodic Table;
- the sub-atomic organization; and
- the organization of the constants to determine any underlying relationship/s.

In biology case studies might include:

- a Periodic Table for the codons (triplicate nucleotides that yield amino acids) (Martinez-Mekler *et al*., 1999; Luo and Li, 2002; Morimoto, 2002); and
- the categorization of living species across the kingdoms according to cell type (Margulis and Schwartz, 1982; Margulis *et al*., 1994).

In psychology case studies might include:

- categories of cognition (Thelen and Smith, 1994; Varela *et al*., 1996).

The SOP model will gain validity only as additional case studies are undertaken and published.

In concluding, the SOP model is multi-faceted and its interwoven nature can be difficult to comprehend. Many of the ideas presented are speculative, and further research is warranted. However, the SOP model offers a new way of looking at a causal event and might offer a step towards a general organizing principle (Barrow, 1991).

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