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Complex Adaptive Behavior: Pragmatic Idealism

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Abstract

The introduction of new concepts is a driver of organizational evolution and transformation. A newly introduced concept can introduce new meaning that is disparate to existing understanding. A new concept may also be interpreted in multiple ways, thereby introducing several disparate meanings. The disparity is resolved through adaptation. The disparity introduces complex adaptive behavior to the organization, requiring suitable changes to its management and design. The development of corresponding doctrine for new concepts, and training for the organization's constituents become indispensable. In so doing, constituents can be involved in the adaptation process through direct participation, and thereby include the cognitive dimension. In this paper we present a means by which the complex adaptive behavior exhibited by an organization when new concepts and ideas are introduced can be studied. We apply the Pragmatic Idealism framework, which provides a theoretical construct where the domain of awareness is an abstraction of reality. This framework supports the coexistence of multiple perspectives and understanding. The framework allows for perspectives that are intrinsically correct, yet holistically incomplete. It includes the human cognitive component into cyber physical system providing a bridge between the physical and information dimensions.

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Keywords: Pragmatic Idealism; Situation Theory; Cyber Physical Systems

Introduction

From a naturalistic perspective, organizational evolution and transformation begin with the introduction of new concepts. New concepts introduce new meaning, which must be reconciled with the existing meaning and purpose of the organization. The organization will adapt to deal with the new concept. It may do so in a variety of means, for example by absorbing the concept and subtly changing its purpose, or by rejecting or isolating the new concept and maintaining its existing purpose. The adaptation to the new concepts in organization can be constrained in the

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physical and information environment, for instance, through a statement of operations, written cultures, or accepted intent. The increasing organizational reliance on cyber physical systems accentuates the relationship between the changes in concepts and organizational adaptation. A newly introduced concept can have multiple meanings for the constituents of the organization. The ensuing disparity in meaning can preclude the evolution and transformation requirements.

The impact of a new concept on an organization must be understood in view of how it is interpreted and the meaning that it is perceived to convey. Utterances can be understood pragmatically, and become meaningful with the situation. Words do not sustain their meaning when taken out of the situation in which they were uttered. How meaning is sustained is related to pragmatic. There are three important terms in this context: locution, illocution and perlocution, which are components of "speech act theory". Locution is the semantics or the verbatim meaning of the utterance. Illocution is the intention of the sender. Perlocution is how the intention of the sender is decoded by the receiver. Existing communication theories delineate the interactive aspect of the act of speech. These serve to provide a traditional spatiotemporal organizational interpretation of the adaptation that follows the introduction of a new concept. The existing models are, however, limited in their ability to reflect on change in meaning and associated actions with the inclusion of cyber physical systems. The ubiquitous nature of the cyber space requires an encompassing theoretical framework to study the complex adaptive behavior in socio-technical systems that rely on cyber physical systems.

Cyber-physical systems and distributed components are part of the cyberspace. Cyberspace is within the information environment which has three dimensions; information, physical and cognitive. Any discussion of adaptation that is confined in the information and physical dimension results in incomplete discussion. This paper discusses improvements to the information environment using a Situation Theory perspective. The improvement provides an encompassing framework for complex adaptive behavior of the cyber physical systems.

1. Situation Theory Perspective

Situation Theory is an abstract conceptual framework used to study the behavior of individuals, the interaction among individuals, the interaction of individuals with their environment, and organizational behavior. This framework focuses on understanding the bounding factors that distort the practicality of situations. Based on the bounding, situations can be simple or complex.

Situation theory deals with *"real objects, real agents, and real data, identifying and gradually refining the various abstract structures that arise from, and govern, the behavior and actions of members of a society. Situation theory is intended to provide a useful alternative view of issues such as linguistic communication and human interaction"*[1]. The study of human interaction is classified into normative methodologies and ethno-methodologies[1, 2]. Normative methodologies explore the human action via identification of social norms that forms the common sense view. Whereas, ethno-methodology perceives human action as fundamental, giving rise to the collection of social norms and a common sense world view. Situation theory can be used to abstract human interaction at the confluence of these two methodologies using the pragmatic idealism perspective.

1.1. Ontological Improvements to the Situation Theory

The abstraction of human awareness, behavior and interaction is important to overcome the hurdles that are presently encountered because of a lack of comprehensible ontological constructs. The physical and mental dimensions are two distinct widely recognized dimensions used to study humans in their environment. This construct is enhanced by the introduction of an ontological information dimension[1] to study human action, communication (interaction) and cognition, Fig.1a.

The naïve ontological construct, shown in Fig.1a, includes individuals, relations, spatial locations, temporal locations, situations, immediate environment, parameters. All of these are constituents of the situational construct that allow studying complex situations in a human oriented way. Subsequent developments, along with the discussion on cyberspace, resulted in the information environment construct[3], shown in Fig.1b. The information environment becomes the environment in which complex adaptive behavior for cyber physical systems with the inclusion of human aspect can be studied.

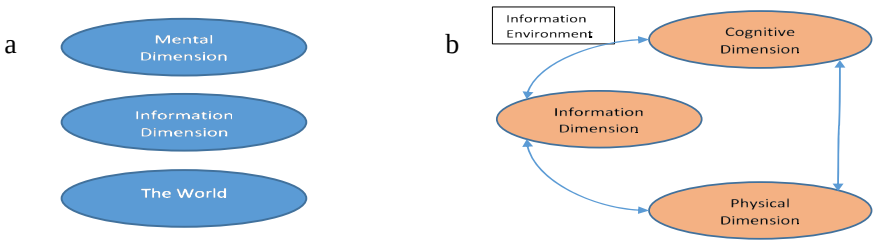

Fig.1 (a) the distinct dimensions that allow a comprehensive scrutiny of cognition, human interaction and human action. (b) The information environment construct that is discussed in JP 3-13 information operations publication.

1.2. Complex Situation

The definition of complexity used in this study is founded on the principles of Pragmatic Idealism (PI). Sousa-Poza[5] introduced a facet of PI with an actionable philosophy. In this construct, understanding is transferred from experience to action. The distinctive characteristic of PI introduced by Sopusa-Poza[5] is the strong emphasis on "fallibilism", and the nature of fallibility. PI focuses on the manner that reality is perceived and understood in complex situations to help improve design and management. PI maintains natural ties to reality. PI introduces a principle that, irrespective of the phenomenon, reality transcends human understanding. This limitation to understanding constitutes "fallibility", which is used to define complexity[5] in PI as *"proportional to the probability of having/making an erroneous knowledge claim* $p(\varepsilon)$*."*

1.2.1. Situational Construct

The Complex Situations construct in Situation Theory includes two distinct components, noumenon and phenomenon. The noumenon represents the unbounded (or quasi-unbounded) participation of an individual in a real situation, whereas the phenomenon is represented by the bounded interaction of an observer with some aspect of reality. This construct ensues in the manifestation of a variety of meanings with respect to situations and individuals. The situation becomes complex or less complex with the cognitive imposition and ability of an individual to understand reality. The incompleteness of awareness and difficulty in maintaining a high level of certitude, allows adaptive behavior for the individual and the organization.

The situational construct model relies on 6 assessments parameters, shown in Fig.2a; nature of the problem domain, worldview or approach predisposition, type of approach selected or required, approach alignment, problem framing and technical expertise[6]. The second distinct feature of PI that enhances studying complex situations is the Reality Domain Perspective (RDP).

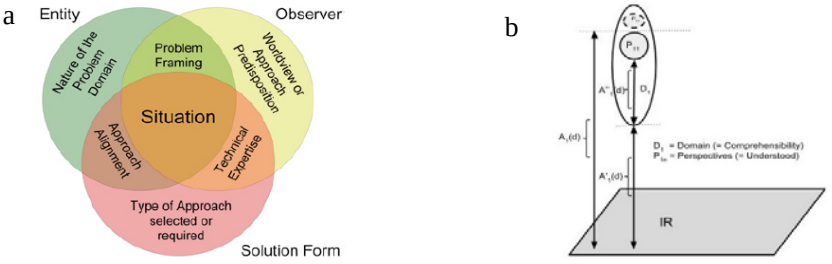

Fig.2 (a) Situational Construct Model and six assessment parameters. (b) RDP model representation of reality with the abstraction distance to reality. A(d) is the approximation distance between reality and what is understood. A'(d) is the approximation distance

1.2.2. Reality Domain Perspective (RDP)

The RDP, as seen in Fig.2b, elaborates how PI maintains the natural ties to reality in understanding dynamic and context specific situations. The RDP forces a bifurcation in abstracting reality that leads to two coexisting states of the individual, namely the individual as observer and the individual as participant[5-7]. Those two states form a syncretic pair. The domain in the RDP construct is composed of three elements, shown in Fig.2a: the "observer", the "entity", and the "solution form". The complexity in this construct emanates from the disparities, or the dissonances between the individuals' domain of awareness. The domain of awareness maintains the individual's ability of understanding a problem. The degree of abstraction in Fig.2b affects the comprehensibility. Consequently, the degree of induced complexity is represented by an abstraction distance, A(d), shown in Fig.2b. Minimizing abstraction distance A(d) is the primary objective in RDP to reduce the complexity. A(d) is related to A'(d) and A"(d). Consequently, both A'(d) and A"(d) become components in establishing the understanding. For instance, to minimize the A"(d) through very tight bounding requires to have larger A'(d). As a result, understanding of the problem may be minimized.

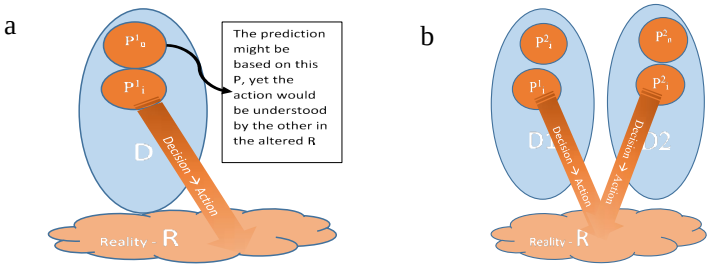

Fig.3 Paradoxes in the RDP Approach. (a) Paradox originates from the same domain of awareness. (b) The paradox emanate from two distinct domain of awareness.

The domain of awareness, D, supports multiple perspective. This allows paradoxical coexistences. The first type of paradox is the incongruence between the two subsequent situations. The first situation is composed of understanding of the problem and the expected behavior. The subsequent situation is composed of the altered "Real" and observed behavior[6]. Both situations are the result of the same generative process. Since the domain of awareness supports multiple perspectives, the expected behavior is both incorrect and correct, shown in Fig.3a. The second paradox emerges when two irreconcilable domains of awareness describe the same entity. The expected behaviors are both correct in their own domain of awareness, however, can be perceived as incorrect in the other domain of awareness. This might happen in the organizational environment where same notion is understood differently yet requires action.

2. Complex Adaptive System (CAS)

A Complex Adaptive System (CAS) is composed of interacting agents, and it will transform or adapt to respond to the environment[8]. In the CAS context, complexity is human oriented. Complexity does not lie in the physical complication of the interaction. Rather it is analogous to the complexity in PI that is probability of making an erroneous knowledge claim. The confluence of the Situation Theory perspective and PI, to the complexity and traditional CAS perspective, permits studying language as a CAS while including cyber physical systems.

2.1. Language as a Complex Adaptive System

Language is an enabler for the human-to-human interaction, which is described as the exchange of utterances. It allows an agent to probe the others' understandings, and awareness. As a CAS, language is composed of interacting agents. The agents' behaviour is based on past, and current interactions, which together form the future possible

behaviour[9]. The CAS framework renders language a dynamic, generative system rather than a static system of grammatical principles. According to Elis this system has four characteristics[9]: *i) the system consists of multiple agents, ii) the system is adaptive, past, present behaviour involves forming the future actions, iii) Competing factors affect the agents' behavior, and iv) the structure of language merges from interrelated patterns of experience.*

3. Organizational Evolution and Transformation

Language in human interaction transpires in various social contexts. For example, organizational activities require intent dissemination, expressing the organizational culture, meetings, and promulgating the organizational goals[10-12]. All these rely on the interactions of individuals through a language, e.g. utterances. Besides these are processes which include individual impositions to the situations. Consequently, the associated meanings of the concepts are constrained by the past and present interactions. When an organization is in a transformation process, new concepts are introduced. These new concepts, for instance, are used in the statement of operations. The adaptation at the level of locution can take place. However, illocution and perlocution may not take place. The recognition of this problem through CAS and the RDP elaborate three facts: (1) A newly introduced concept can have disparate meanings, thus paradoxes can be seen, (2) The adaptation is a process and will eventually cease to take place, and (3) The disparity may continue to exist. PI permits studying language in a way that the aggregated effect of many interacting constraints, including the structure of thought process, perceptual motor biases, cognitive limitations, and social-pragmatic factors[13] are taken into consideration[14].

The manifestation of these factors as constraints becomes noticeable when humans aim to convey the meaning in the most efficient way, for instance, in disseminating intent. Extracting the meaning is the essential aspect of the communication. Once the locution is imparted, even if there is a tacit agreement between the interacting agents, they will use a variety of operative assumptions in the presupposition framework of the context to decode the meaning from the locution. The significance of these presuppositions is that they don't emerge from the context of the message, rather from contextually formed presuppositions which are in the agents responsibility[15]. The existing parameterizations to the cyberspace delineate the human involvement in the cyber physical system as cyber persona. However, the cyber persona cannot sufficiently reflects the human cognitive dimension. To include the human and associated impositions to the cyber physical system, the information environment is improved with the PI framework.

4. CAS Perspective in Cyber Physical Systems

4.1. Information Environment and RDP

The syncretic nature of PI and the information environment generates a comprehensive framework. It is systemic and holistic including all the aspects of an organization; cognitive, physical and information. The advancements in cyber physical system renders human interaction easier and quicker than ever before. Yet, there are constraints as the efficacy of the conveyed message. The transformation and evolution of an organization becomes accessible to anyone immediately. For instance, the newly introduced concepts are disseminated right away. However, the dissemination of these terms via cyber physical systems preclude the full conveyance of the meaning with the correct cognitive involvement. It can be concluded that the adaptation at the locution of a concept can be attained. Further processes are, however, required for illocution and perlocution to effectively convey meaning. The introduced syncretic framework, shown in Fig.4 a and b, maintain the natural ties to reality for cyber physical systems. The framework elaborates causes for the paradoxes, cognitive dissonances and disparities for the locutions by recognizing the associated cognition to the locution shown in Fig.4b.

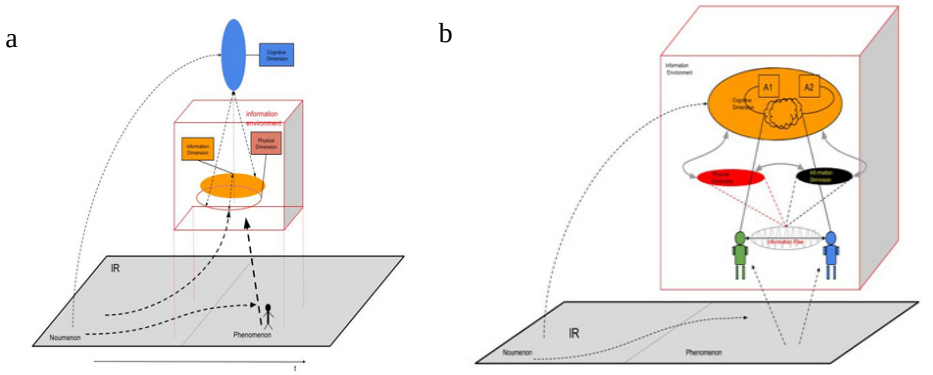

Fig.4 (a) Information Environment in Situation Theory Perspective; (b) Information exchange and the correspondence in cognitive dimension in information environment.

4.2. Pragmatic Idealism and CAS

Since cyber space is in the information environment, it requires detailed conceptualization to study CAS for cyber physical systems. The introduced syncretic construct provides a comprehensive CAS framework for cyber physical systems. The PI framework enables the probabilistic nature of understanding. Regardless of the origin of the cause, either endogenous or exogenous, the existence of multiple perspectives in one domain of awareness, as seen in Fig.2b, renders the disparity a source for probable change and subsequent adaptation. The syncretic construct includes not only phenomenological but also noumenological effects. The Noumenon, in this case, is defined as the *"mind-imposed contrivance, allowing the individual to operate with the conceptual scheme"*[16]. Noumena induces unity in recognizing the three major faculties of human mind; sensibility, understanding and reason. In the CAS approach, these human associated constraints of are of paramount importance, especially in conceptual works. Kant's statement, *"contemplation of any type of change with respect to the operational sensibility, requires a change with respect to the operation of understanding"*[16] also applies. Therefore, the natural ties to reality make the cognitive modality of the change for the CAS approach in the discussion of cyber physical system critical. Without including what Kant refers to as the *"curbing factor for pretension of sensibility"*[16], or in other words, those things that can be experienced but not sense, will result in an incomplete understanding of the problem. To implement the proper interaction strategies to perturb the desired / required perspective in the domain of awareness, a complete recognition is required. The perturbed perspective entails the understanding. This understanding can, however, be permanent or not. The situation and pragmatics of the individual or organization determines the life span of the perturbed perspective.

5. Conclusion

The Complex Adaptive System framework is important in system studies. The necessity of adaptation accentuates itself with the organizational reliance on cyber space. Only perceiving the cyber physical system in the information and the physical dimension precludes the implication of CAS characteristics to the cyber physical systems. For example, causality in adaptation needs to be addressed properly. The noumenological and phenomenological components of causality can be properly addressed in pragmatic idealism and the ensuing syncretic framework. Cyber space itself is difficult to comprehend, and the inclusion of a comprehensive human cognitive component is missing in the current cyber-physical system perception. The lack of comprehensive theoretical studies makes understanding endeavours of cyberspace incomplete. During the evolution (or transformation) of a system (e.g. organization) paradoxes are crucial in two ways. (1) Paradoxes are critical in identifying the factors that impede adaptation, and (2) recognition of paradoxes can facilitate identification of latent factors that impede adaptation. For instance, the disparity in meaning of a new concept can be latent, and require extensive work in the case of late recognition. An adaptation in locution is not sufficient because the disparity results from multiple specific cognitive processes. The inclusion of cognitive dimension (shown in Fig.1and Fig.4) as well

as algedonic ties back to reality are indispensable in this regard. A situation awareness framework that relies intensively on cyber physical systems will be incomplete without human cognition. In the model that is presented in this paper, situation awareness will be able to grasp the noumenological causality. This will help in the recognition of emergent, unknown constraints that induce complexity and chaotic behaviour. This will in turn facilitate and improve the system's ability to adapt.

References

1. Devlin, K., *Situation Theory and Social Structure*, in *Knowledge Representation and Reasoning Under Uncertainty*, M.M.L. Pólos, Editor. 1994. p. 197-237.
2. Garfinkel, H., *Studies in Ethnomethodlogy* 1967: Polity. 304.
3. *Information Operations Joint Publication 3-13*, D.o. Defense, Editor. 2012.
4. *Department of Defense Dictionary of Militrary and Associated Terms*, D.o. Defense, Editor. 2008.
5. Sousa-Poza, A., Correa Y. *Pragmatic idealism as the basis for understanding complex domains: the trinity and SOSE.* in *IEEE SMC 2005* 2005. Hawaii.
6. Sousa-Poza, A., *A Narrative of [Complex] Situations and Situations Theory.* 2013. **21**: p. 13-44.
7. Sousa-Poza, A., Kovacic Samual, Keating Chuck, *System of systems engineering: an emerging multidiscipline.* Int J Syst Syst Eng, 2008. **1**: p. 171-188.
8. Bar-yam, Y. *New England Complex System Institute: Concepts - Adaptive*. 2011; Available from: http://www.necsi.edu/guide/concepts/adaptive.html.
9. Elis, N.C. *Language is a Complex Adaptive System* in *Language as a Complex Adaptive System.* 2007. Santa Fe Institute
10. Bratman, M., *Shared Cooperative Activity.* The Philosophical Review 101, 1992. **101**: p. 327-341.
11. Bratman, M., *Shared Intention.* Ethics, 1993. **104**: p. 97-113.
12. H., C.H., *Using Language*. 1996, Cambridge Cambridge University Press.
13. Chater, M.H.C.N., *Language as Shaped by the Brain.* Behavioral & Brain Scineces 2008.
14. Canan, M., A. Sousa-Poza, and S. Kovacic, *Semantic Shift to Pragmatic Meaning in Shared Decision Making: Situation Theory Perspective.* International Journal of Design & Nature and Ecodynamics, 2015. **10**(3): p. 11.
15. Rescher, N., *Communicative Pragmatism*. 1998: Rowman & Littlefield Publishers, Inc.
16. Rescher, N., *Kant and the Reach of Reason*. 1999: Cambridge University Press.