SOCIO-TECHNICAL SYSTEM WHOLENESS: A THEORETICAL MODEL APPLIED TO HIGH VALUE ASSET SECURITY PROGRAMS

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ABSTRACT

Researchers and practitioners continue to study the causes of high-consequence events such as terrorist attacks or catastrophic failures of complex socio-technical systems. These studies have relevance to postulated and real events and are important, but limited. Analyses focusing on linear causal pathways are common in vulnerability and probabilistic risk analyses. These linear pathways typically focus on individual human error or technical system malfunctions. The linear approach is limited in its value as broader systemic issues can remain hidden.

A new model is proposed using an integral approach that describes vulnerability from a systemic wholeness perspective. Wholeness is a concept that has many meanings, from various academic and practical perspectives. This paper offers a new definition of the wholeness concept that draws from earlier ideas but is distinct in its application. The model can be used to focus attention on many integrated systemic domains simultaneously in a continuous and ongoing process. The model's foundation is a four-quadrant framework that describes subjective, objective, inter-objective, and inter-subjective domain spaces. Vulnerabilities or systemic deficiencies within these spaces are described using the metaphors of system holes and shadow aspects. Collection and depiction of these deficiencies allow for analysis, revealing common patterns of concern. Clarifying inter-organizational relationships is also important and highlights the need for clear systemic and sub-systemic boundary definitions.

Improvement of industrial, community, or infrastructure security requires a perpetual process that is described by a dynamic dimension to the wholeness model, drawing from methods employed in participatory action research. This paper presents the main points of the wholeness model, shows how deficiencies are analyzed, and provides examples of characteristic patterns of concern.

INTRODUCTION

Systemic failures are increasingly common in modern human society. Humans have grown reliant on complex technological systems for transportation, energy production, general environmental comforts, entertainment, and many other dimensions of life. Organizations too are becoming more diverse, and complex, and individuals look to workplaces, schools, and local communities for resources to sustain life, give a sense of belonging, and provide for individual fulfillment and actualization. Interdependencies between technological systems and human systems define, in part, the *socio-technical systems* that are the focus of this paper. Generally, these socio-technical systems are beneficial and add to human welfare. Sometimes, however, systems fail and often, the value of failure can be quite high.

A FRESH PERSPECTIVE ON SECURITY PROBLEMS

To offer a unique perspective on the vulnerability socio-technical systems to failure, I will introduce a new term, and corresponding theoretical model. *Wholeness* is the term associated with a concept and model used to organize and evaluate a number of socio-technical system characteristics that have unique bearing on security problems. A dictionary definition of "whole" is simply "something that is complete or full." It is "not lacking in any of its parts; nothing is left out" (Whole, n.d.). The proposed model will describe vulnerability as a lack of wholeness, and highlight characteristics that must be considered by security professionals.

The term wholeness is very broad, and it will require definition and orientation to distinguish this concept from other ideas with similar descriptions. Very generally the various definitions of wholeness can be placed along a spectrum from the philosophical at one end to the very practical at the other. The meaning of wholeness as I am using it is situated somewhere near the middle of that spectrum, and has practical value for socio-technical systems. The reason that the proposed definition of wholeness does not fit cleanly at the empirical end of that spectrum is because high value asset facilities and processes are not strictly technical systems, rather they are *socio-technical* systems involving human individuals and collectives in relationship to technologies. Therefore, collective and individual human dimensions must be considered in addition to the technology. Some scholars and philosophers use wholeness as a description for the highest levels of human aspiration and evolution (Koestler, 1968; Laszlo & Laszlo, 2008; Maslow, Stephens, Heil, & Bennis, 1998; Smuts, 1926; Teilhard de Chardin, Huxley, & Wall, 1959). These positions, although interesting and important, are not the primary focus of the proposed model.

Wholeness is often used in relation to, and sometimes interchangeably with, the concept of *holism*. Holism is a term coined by the philosopher Jan Christiaan Smuts in his 1926 book, *Holism and Evolution.* In this work, Smuts (1926)sought to describe an experience of reality that involved an interaction of wholes towards a greater unifying and universal force. This philosophy reflects a universal aspiration to higher forms of organization and consciousness. It specifically addresses problems at a different level than what is needed to support directly this theoretical model of socio-technical systemic wholeness. The theoretical physicist David Bohm's observation of the etymology of the word "wholeness" as "health," (Bohm, 1981, p. 3) comes closer to the intended meaning in relation to complex socio-technical systems.

The concept of wholeness that is the focus of this paper can be further clarified by considering Ken Wilbur's four-quadrant integral model (Wilber, 2007), an adaptation of which is shown in Figure 1.

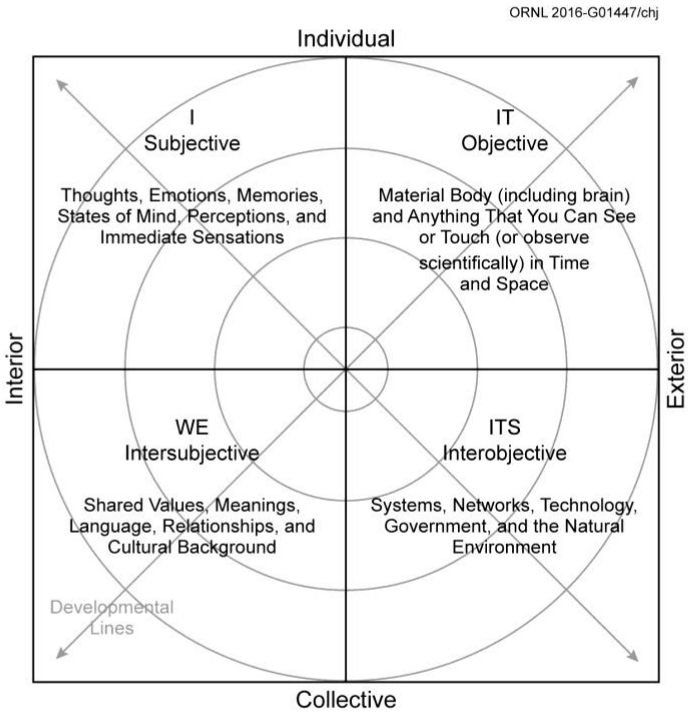

***Figure 1*. Ken Wilber's four-quadrant model. Adapted from *The Integral Vision* (p. 71) by K. Wilber, 2007, Boston, MA: Shambhala. Copyright 2007 by Ken Wilber.**

This model is organized around a vertical pole that represents the individual and collective differentiation, and the horizontal pole representing interior and exterior characteristics. Each quadrant describes areas of importance for an integral view of socio-technical systems. The concentric rings represent *levels* of development increasing from an atomistic (external) or egocentric/ethnocentric (collective) level closest to the center to an integrated, world-centric holistic view in the outer rings. These levels also bring clarity to this application of the wholeness concept. For the ideas presented in this paper, I do not share the interest with the authors and thinkers dealing with the highest levels of human development, represented by the outermost levels in the diagram. I am interested, however, in maximizing development to the *level consistent with the risk* of systemic failure. A practical example will clarify: if a company endeavors to build and operate a nuclear power plant, they must have sufficient understanding of, and make accommodations for, the technical complexity of the task. These items are described by the lower right quadrant, the external collective aspects. The nuclear power plant managers must hire staff with cognitive and emotional competence commensurate with their assigned tasks, which are individual characteristics described by the upper left quadrant. Managers and leaders must foster a culture (lower left quadrant) of balanced awareness of observable factors (upper right quadrant) indicating systemic health. *Wholeness means commitment to a constant and progressive process of development in all quadrants and all developmental lines*.

The number of developmental lines is vast, and it is necessary to limit analysis to those that can be described and supported by available information and experience. Lines are related to the quadrants (e.g., an individual cognitive development line would be represented in the upper left quadrant) and are represented on the figure as lines radiating from the center.

To further clarify, I offer an example related to an insider threat concern. If an organization processes classified or sensitive information, and is thereby vulnerable to the insider espionage threat, they must hire individuals without a predisposition to malevolent behavior and have a high level of moral development and emotional intelligence. These characteristics would be represented by multiple developmental lines in the upper left quadrant of the integral model. Beyond the individual, the organization's security culture must support balanced attention to malevolent behavior, which can be represented by developmental lines in the lower left quadrant. The organization may employ systems and procedures for detection and protection that could be described by developmental lines in the lower right quadrant. An organization would be moving towards wholeness if they recognized deficiencies and sought to improve in all of these integrated characteristics. I argue that these must be developed simultaneously, or at least iteratively as deficits may arise or be obscured in one area by developmental progress in another quadrant.

The definition of wholeness as presented thus far includes attention to all quadrants, all levels, all lines; "AQAL" in Wilber's shorthand (Wilber, 2007, p. 66). It also includes development along a number of identified lines. How then, would an individual, an organization, a regulatory agency, or a state entity go about attending to this process of becoming whole? Organizational wholeness is a term proposed in opposition to the idea of organizational *perfection*, which implies a singular end state and a linear path to that state of perfection. Organizational perfection is a notional concept and any definition, even if attempted, would be incomplete. Managing complexity in socio-technical systems requires recognition that organizations develop in all quadrants and all levels, respecting the generative nature of the process. Implicit in this unfolding process of becoming whole is that the end state cannot be predicted with complete accuracy.

PARTICIPATORY ACTION RESEARCH HOLON FRAMEWORK

Another model is helpful in understanding the simultaneous and iterative process of development. The model or framework comes from work in participatory action research (PAR) and involves an interactive intervention into a system to with a goal of affecting change. The PAR process is a continuous loop of reflection on the goal and ultimate purpose; planning and designing to meet the objectives reflected upon; acting on the plan; and, observing the tangible outputs, results, and data. This framework was refined by Kineman (2016), who describes it as a *holon* framework. The term "holon" was coined by Koestler (1968) and describes systems that simultaneously hold characteristics of subsystem wholes and parts. Observing that most highly complex socio-technical systems are ever changing or are in environmental contexts that are equally as volatile; the application of this process is relevant to the movement towards wholeness. The PAR holon framework corresponds to Aristotle's four causes (Falcon, 2015). Translating Aristotle's terminology, *final* represents the expected outcome and equals *reflect*. Aristotle's *form, or formal* cause, represents the form or structure of the entity; what is to be. This equates to the *plan* in PAR holon framework. Aristotle's *efficient* cause is the primary actor or agent of change, which corresponds to *act*. Finally, Aristotle's *material* cause is the easiest to understand and represents that out of which the form comes. Given these definitions, Figure 2 is shown to summarize and organize these concepts. The dynamic process described in the framework is relevant and represents the continuous process of growth, improvement, and evolution necessary for all viable and sustainable systems. It corresponds to what Senge (1990) described as a *learning organization*.

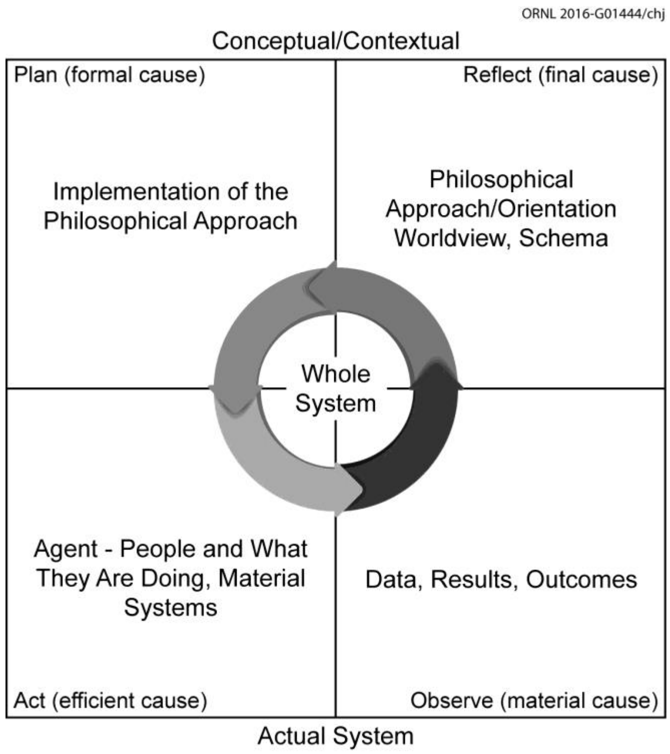

***Figure 2*. PAR holon framework. Adapted from "Systems Research Framework" (p. 29), by J. J Kineman, 2016, in M. C. Edson, P. B. Henning, and S. Sankaran (Eds.), *A Guide to Systems Research*. New York, NY: Springer.**

For high value asset facilities and their support systems, it is necessary for organizations to commit to an ongoing cycle of reflection, action, modification, and observation of results.

Despite the progressive, comprehensive, and integrated nature of the process identified in Figure 2, its application does not guarantee success. Because it is a continuous cycle, reflections about ultimate purpose can influence how an organization sees and interprets data from the earlier stage. If these assumptions are misguided, the cycle can lead in a regressive direction. The tendency for underlying assumptions to influence the way individuals or organizations collect and process data is described by Argyris in his ladder of inference model (Senge, 1994), where beliefs and assumptions change perspective. The PAR holon framework is a four-quadrant model, but it is similar to Wilber's integral model only in this dimensional respect. The PAR holon framework is presented as an explanation of the *dynamic and continuous* process of system improvement and ongoing organizational learning. This represents the *how* aspects of organizations becoming whole. The model of *what* requires attention is represented by Wilber's integral model (Figure 1). There are only four developmental lines represented on the figure; one per quadrant. In practice, many developmental lines could exist or be the focus of an initiative to improve organizational wholeness. For example, Figure 3 is presented as an example based on the Robert Hanssen espionage case(U.S. Department of Justice Office of the Inspector General, 2003). This figure highlights three relevant developmental lines in the upper left quadrant that represent Hanssen's individual circumstance and one system relevant developmental line in the lower right quadrant representing monitoring systems employed by the FBI.

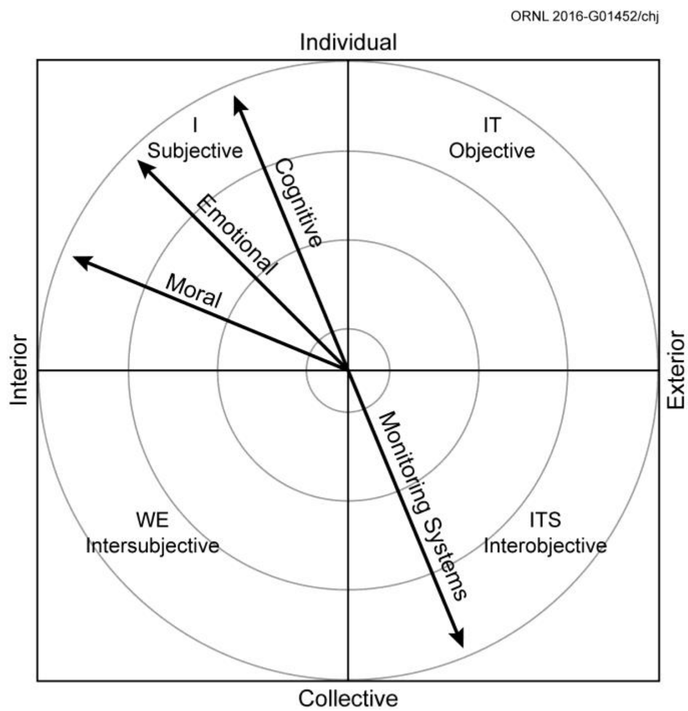

***Figure 3*. Developmental lines associated with an espionage case.**

A hermeneutic analysis of Hanssen's case data revealed that he was highly developed cognitively, but was low in moral compunction and emotional intelligence. This is a dangerous pattern that can be seen in other case circumstances. Generally, Hanssen was not the kind of individual that should have been considered for employment at the FBI; an evaluation that we have the luxury of making in hindsight. How then, can we best learn from these circumstances and be alerted to such patterns in other circumstances. It is very difficult to determine upper left quadrant characteristics with accuracy and organizations typically do not use these measures in employment decisions. Without accurate methods of discernment, organizations would need a very high level of development in security monitoring systems. Here we see further illustration of the disastrous circumstances associated with Hanssen as an insider threat, as he had full access to the very systems that gave insight into his own investigation.

SYSTEMIC DEFICIENCIES: HOLES AND SHADOW ASPECTS

To improve clarity in describing these socio-technical system deficits, I propose the metaphors of *holes* and *shadow aspects*. The identification of holes could include metaphorical descriptions of a lack of development or attention to a technical or organizational element, or they could mean literal holes in defensive hardware or electronic systems. Consistent with practical experience, a hole could represent a gap where a perpetrator could penetrate a security system or the omission of a barrier or safeguard. A hole could also represent an organizational element omitted from the larger system for cost savings or due to oversight. Determination of where along developmental lines may be very difficult because security managers lack useful instruments. In most cases, however, indications of deficiencies from the hole and shadow aspect perspective are available and can be used to guide programs for systemic improvement.

DEFINING SYSTEMIC BOUNDARIES

One of the strengths of the wholeness model is the requirement to discuss and define systemic boundaries. The wholeness model may relate to an organization or a facility. One could continue to expand this model to accommodate all dimensions related to a security concern. For example, the wholeness model could be applied to an entire critical asset supply chain. This approach is not optimal, as it might obscure important distinctions and relationships. A better approach might be to define systemic boundaries around two or more entities and show relationships between or among the systems. Figure 4 is a representation of distinct systems with critical relationships described. Note that deficiencies can be identified in the "System A" or "System B" representations, and also in the relationships between them.

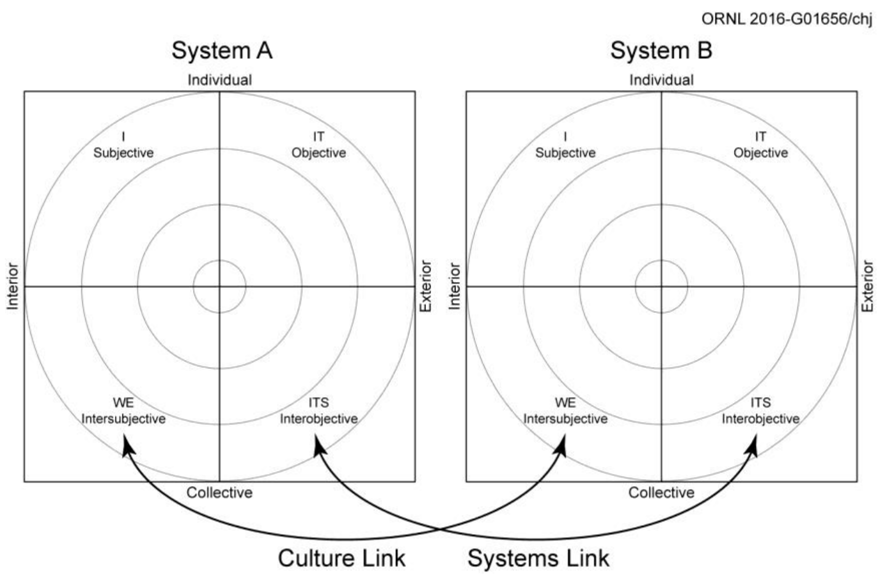

***Figure 4*. System and culture domain linkages.**

Another consideration involves systemic distinctions represented temporally by various phases. An example might be a nuclear facility that is in a defensive or preparatory phase. This facility has a different systemic manifestation while in the response phase. Normal operations have different requirements than emergency operations and it is fruitful to analyze systems in both phases. A graphical representation is shown in Figure 5.

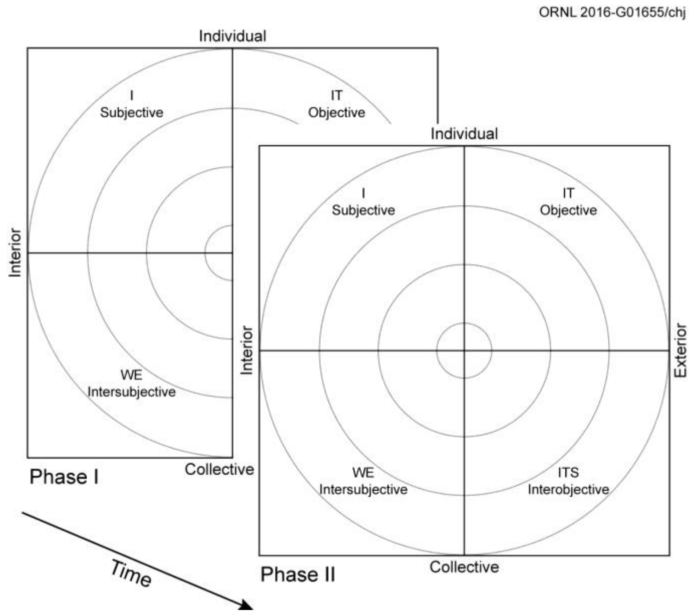

***Figure 5*. System phase differences.**

Defining system boundaries can be a difficult exercise. This very exercise, however, is a valuable part of the reflective process described by the PAR holon framework. This model serves to re-enforce another important dimension of the wholeness model. The *reflect* quadrant of the PAR holon dynamic shown in Figure 3 requires consideration of many dynamics with respect to systems. Spatial and temporal considerations are critical, as are linking relationships. Distinctions can thereby be accommodated into larger system boundaries reinforcing Koestler's (1968) definition of holon as having the dual nature of distinction and inclusion into greater wholes, or larger systems. All of the representations of the systems that describe the cases in this study are correct, but they also have limitations. Nevertheless, they are all useful if they serve to broaden the systemic conversation.

CONCLUSION: THE WHOLENESS SYMBOL

I have consistently used Wilber's (2007) integral model as a container for systemic representation. Any depiction is the beginning of a systemic conversation, not the end. A chosen representation, applied to a specific circumstance may be part of a larger system, or it may contain subsystems. Holes and shadow aspects too, can exist at any systemic level. If the holes and shadow aspects are graphically represented as defects, the systemic wholeness aspiration would be a system free of defects. Freedom from defects is only aspirational as I believe it is impossible in actuality. Nevertheless, this aspiration can be represented by the four-quadrant integral model with the PAR holon dynamic enclosing and in constant motion. This symbol is shown in Figure 6.

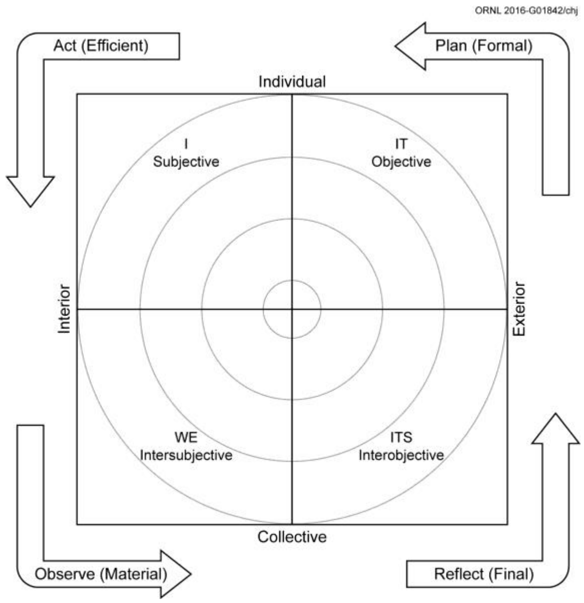

***Figure 6*. Wholeness symbol.**

The symbol is intended to represent and accommodate the energy of change. The integral four-quadrant model is holonic and can shrink or expand to accommodate the systems of interest. The *reflect, plan, act, observe* cycle continues and addresses deficiencies as they arise. I have chosen the word "symbol" rather than "model" at this point, to re-enforce the fact that with complex systems, and given constant change, perfect wholeness cannot be achieved. Defects can and will arise, and the dynamic energy represented by the arrows is a kind of sentinel process. Commitment here is necessary by organizational leaders. Senge (1990) described this commitment as being "continually focused on enhancing and expanding their collective awareness and capabilities" (Senge, 1990, p. 4), which is the energy necessary for creating a learning organization. The capacity of an organization to learn, and to remain vigilant for malevolent forces are critical for socio-technical system security. The task is far from simple. The greatest challenge that researchers and practitioners face is to maintain the focus of attention and the application of resources to this critical problem.

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