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CASE STUDY RESEARCH: THE VIEW FROM COMPLEXITY SCIENCE

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Abstract

Many wonder why there has been so little change in care quality, despite substantial quality improvement efforts. Questioning why current approaches are not making true changes draws attention to the organization as a source of answers. We bring together the case study method and complexity science to suggest new ways to study health care organizations. The case study provides a method for studying systems. Complexity theory suggests that keys to understanding the system are contained in patterns of relationships and interactions among the system's agents. We propose some of the "objects" of study that are implicated by complexity theory and discuss how studying these using case methods may provide useful maps of the system. We offer complexity theory, partnered with case study method, as a place to begin the daunting task of studying a system as an integrated whole.

Keywords

Case study methods; research; complexity science; health care organizations

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Dr. Jane Russell, Family Physician, spoke at a luncheon with great zeal about the benefits of preventive medicine, transferring her enthusiasm to the audience of family health care providers. It was evident that the individuals in this group felt strongly about the value of prevention as a part of their medical practice. When we examined Dr. Russell's practice for the level of preventive services delivered, therefore, we were greatly surprised to find that, while most women in her practice were up-to-date with mammograms, in only 10% of her patients who smoked tobacco was there any documentation of their ever having been counseled to stop smoking.

In order to understand and improve the complex contexts and interactions that lead to anomalies such as those presented by Dr. Russell, theoretical models and research methods are needed for understanding health care organizations. These models and methods need to address questions such as: "Why have we seen so little change in what is being done for clients despite substantial knowledge in the form of best practice guidelines?" "Why is it that a physician,

who is enthusiastic about preventive services, is unsuccessful in delivering them to her patients?" "Why is that 77% of nursing homes fail to meet federal regulations – the accepted standards of care (American Health Care Association, 1998)?" Questioning why current approaches are not making true changes in health care practice has drawn our attention to the organization itself; it has meant changing what we view as foreground and what we view as background in health care delivery. For example, as an industry, we have relied heavily on continuing medical education as a way to create changes in health care believing that the physician is the foreground – or most important point for change – and the practice environment is background – or only incidental to the physician's behavior (Institute of Medicine, 1996). Flipping those, however, suggests that the physician's level of knowledge about something may not be the best place to begin when trying to understand improvements in health care. Past empirical observations have convinced us to bring the health care organization to the foreground of research (Anderson, Issel, & McDaniel, 2003; Crabtree, Miller, Stange, 2001; Crabtree, Miller, Aita, Flocke, & Stange, 1998; Institute of Medicine, 2001; 2004; Miller, Crabtree, McDaniel, & Stange, 1998). We have become convinced that it is within the context of the organization itself that many of the answers lay for understanding and improving health care delivery.

Researchers have often attempted to understand health care organizations by using case study designs; however, these designs are only as good as the theoretical model driving the research. Traditional case study designs, while often helpful, have been driven by theoretical models that are not congruent with the nature of the health care organizations we study. Researchers have studied organizations as though they were mechanistic systems with straightforward cause and effect linkages and dynamics that could be predicted from historical data (Miller, 1993), leading to case study designs focused on understanding the elements of the organization through an examination of these straightforward cause and effect linkages and predictable dynamics. Many now believe that health care organizations are complex adaptive systems (Anderson et al., 2003; Begun & White, 1999; Crabtree, 2003; McDaniel & Driebe, 2001; McDaniel, Jordon, & Fleeman, 2003; Plsek & Wilson, 2001) in which relationships are critical, generally nonlinear, and lead to unpredictable dynamics (Capra, 1996; Casti, 1994; Kauffman, 1995; Mainzer, 1997; Stacey, 1996). Case study designs can be more informative when they assist us in revealing these characteristics of complex adaptive systems.

Our purpose in this paper is to describe how case study designs, in combination with a complexity science perspective, provide important new tools for studying organizations (Crabtree et al., 2001; Stake, 1995; Yin, 1994). First, we contrast the view of organizations as mechanistic systems with the view of organizations as complex adaptive systems. Then we pose extensions to case study designs by suggesting aspects of health care organizations that have not been well studied using traditional theories and by providing examples to show new insights that can result.

COMPLEXITY THEORY AS A BLUEPRINT FOR FRAMING CASE STUDY DESIGNS

Newtonian understandings of the world have strongly influenced scientific methods for understanding organizations (Capra, 1983; Wheatley, 1992; Driebe, 2000). Most available analytic techniques have us break a system into smaller bits, study the bits and when we believe that we understand the bits we put them all back together again and draw some conclusions about the whole. Most traditional organizational theory leads us to view organizations as machine-like with replaceable parts, and if each part is doing its job, the organization will run smoothly (Morgan, 1986). These theories assume that stability is the natural state of an organization, that an organization consists of functions and roles that are carried out by people who are replaceable with little damage to operations, and where results are predicable and

replicable (Thietart & Forgues, 1995). These ideas have created the ethos that if leaders and administrators are rational and command a “well-oiled machine,” then their organizations will be successful (Morgan, 1986). Transferred to health care, these theories suggest that financial incentives, regulatory policies, and best practice initiatives will be successful recipes for improving outcomes in organizations. Why then, has it been so difficult for clinical practices, hospitals and nursing homes to adopt best practices or comply with regulations and why have current approaches not been more successful in achieving wide-scale improvements (Institute of Medicine, 2001; Wunderlich & Kohler, 2001)? Perhaps it is because a system can only be understood as an integrated whole. “A complex system is not constituted merely by the sum of its components, but also by the intricate relationships between these components. In ‘cutting up’ a system, the analytical method destroys what it seeks to understand” (Cilliers, 1998, p. 2).

Leaders and administrators explain the failure of traditional approaches with the idea that things almost never happen as predicted and that adopting “recipes” will not work in their particular organizations because of unique actors, political situations, and random events that interfere with implementation or replication. These managers describe a world that is unpredictable and disorderly. This reality suggests that the machine model of organizations fails to capture the dynamics of today’s organizations (McDaniel & Driebe, 2001; McDaniel, 1997; Stacey, 1996; Wheatley, 1992).

The science of complexity (Mainzer, 1997; Waldrop, 1992; Kauffman, 1995; McDaniel & Driebe, 2001) provides very different models for how organizations work. In contrast to the machine model, complexity theory suggests that organizations are organic, living systems (Capra, 2002). For example, the cell is used as a model for the organizational design at one high-tech firm (Coleman, 1999). The cellular firm is likened to an amoeba that changes with its surroundings—it is flexible because people act quickly according to accepted protocols of knowledge sharing which substitute for hierarchical controls. Employees work in a common direction through self-control. Another common model for organizations is the brain with its communication and information transfer networks (Mainzer, 1997) and self-organizing capacities (Morgan, 1986).

Models from complexity theory have in common the notion of organizations as dynamic, living, social systems (Capra, 2002). In this view, health care organizations are social systems created to organize the activities and resources needed to provide care. Like living beings, social systems, are sustained by "a never ending process of change, which creates new order" through self-organization, self-creation, and creativity (Merry, 1995, p. 33).

Many believe that health care organizations are complex adaptive systems (Anderson et al., 2003; Crabtree, 2003; McDaniel & Driebe, 2001; Plsek & Wilson, 2001; Zimmerman, Lindberg, & Plsek, 1998). Considering the properties of complex adaptive systems can provide insights for studying health care organizations as integrated wholes. “Because complexity results from the interaction between the components of a system, complexity is manifested at the level of the system itself” (Cilliers, 1998, p.2). A key to understanding the system as an integrated whole thus lies in understanding the patterns of relationships among its agents (Cilliers, 1998; Gell-Mann, 1994; Stacey, 1996; Wheatley, 1992). In making this apparent, complexity theory makes the idea of studying an integrated whole a less daunting task. In Table 1, we describe several key properties of complex adaptive systems. Several sources are available that describe in more detail the properties of complex adaptive systems (Anderson & McDaniel, 2000; Capra, 1996, 2002; Cilliers, 1998; Goldstein, 1999; McDaniel & Driebe, 2001; Stacey, 1995; Waldrop, 1992) and readers wishing a fuller explication of the properties and their implications are encouraged to consult them.

Recognizing the properties of complex adaptive systems, it becomes apparent why improvements in the health care industry have been difficult to achieve using regulatory or one-size-fits-all strategies (Crabtree, 1997; Institute of Medicine, 2001; Stange, 1996) and why new approaches for studying health care organizations are needed. We all possess mental maps that we use to understand the world. For most of us, our mental maps are entrenched in the machine model of organizations (McDaniel, 1997; Waldrop, 1992; Wheatley, 1992). It may be fairly straightforward for researchers to abandon an explicit theory, for example, the theory that physicians will increase preventive services if they are given a strong enough incentive. It is more difficult, however, to discard our implicit mental models of the world and these implicit models influence even the questions that we will ask those whose "voice" we want to hear and understand (McDaniel et al., 2003). We offer complexity theory as a stimulus for shaking loose some of the fundamental beliefs many of us hold about the world. By alternating our long held perspectives, we have a new, and in many ways refreshing, lens through which to view health care organizations.

EXTENDING CASE STUDY DESIGNS USING A COMPLEXITY SCIENCE BLUEPRINT

We can extend traditional ideas about the execution of case studies (Eisenhardt, 1989; Yin, 1994) by applying the blueprint of complexity science. This will lead to new research strategies for fruitfully using case studies in health care settings. In this section, our purpose is to identify several of the potential extensions of case study design. By no means do we claim to have exhausted these potentials. Nor do we wish to suggest that conventional understandings of case study research need to be discarded. Rather, we present the case study as a research approach uniquely suited to carrying out a study designed from a blueprint of complexity theory. The case study strategy with these extensions becomes a powerful tool for increasing our understandings of health care. These extensions are as follows:

• Understand interdependencies

Through complexity theory we recognize that systems do have elements but it is the interdependencies and interactions among the elements that create the whole. Thus complexity theory suggests that studying the interdependencies and interactions among the elements, as well as the unity of the system itself (McDaniel, 2004; Price, 1997), will provide critical insights for understanding an organization and its system properties. Identification of these interdependencies requires prolonged engagement with the system. Actions are interdependent with actions. Ideas are interdependent with ideas. And, importantly, actions are interdependent with ideas. Our tendency in case studies is to isolate actions and ideas, that is, we describe them independent of each other. To understand the system, however, requires that we understand these interdependencies (Capra, 1996; Lee, 1997). Thus, when we see either a discrepancy or a consistency between ideas and actions, this is a cue to search for and describe the underlying interdependencies. For example, the first author and colleagues collected in-depth case study data over a six-month period from a nursing home revealing that nursing assistants held child care/rearing as a guiding mental model of a patient’s behavior and thus interpreted a patient’s crying, not eating, and taking to the bed as a temper tantrum. The nurse aides acted accordingly by giving her a “timeout.” Understanding the nurse aides’ mental model (ideas) shed meaning on the action; it makes sense to give a time out for a temper tantrum, a standard child-rearing practice. However, in isolation, the action appears thoughtless and cruel. The case study method with the blue print of complexity science, revealed this interdependency through direct observation combined with interview methods that explore the participants explanations, and analysis that paid attention to the interdependencies between thought and action.

Further, because of the co-evolutionary nature of the system, we must pay more attention to the interdependencies across the boundaries of systems. Traditionally case studies bound the case and then study phenomenon within the boundary. Complexity science suggests that important insights can be gleaned by studying the behavior that occurs at and across the boundaries that define the case. For example, in another nursing home in the nursing home study mentioned previously, interdependencies were identified between external regulators (surveyors), the nursing home, and the resultant relationships between managers and staff. A history of multiple survey deficiencies coupled with frequent surprise visits from surveyors caused the nursing home managers to believe that the surveyors held a bias against the facility because of past poor performance and that they were citing them for things that would be overlooked on a nursing home with a better history. In other words, the regulators were co-evolving through interaction with the facility over time. In turn, the managers constantly monitored nursing home staff for rule violations with the strategies of correcting behavior. As a result, staff described the nature of their interactions with managers as “scolding” and “chewing out.” Morale was low and turnover was high. The managers had difficulty seeing beyond the regulatory issues to other important aspects of managing the nursing home. Here we thus suspect that the interdependencies across external boundaries were co-evolving with the relationships within the facility and knowing the system at this level, enabled better explanation of internal behaviors. These findings were revealed through direct observation and interviews with multiple agents at multiple levels in the system as well as review of survey reports. In addition, the analysis allowed for synthesis such that the patterns were revealed.

- **Be sensitive to dimensions of relationships**

  There are several dimensions of relationships you want to be sensitive to and you should decide ahead of time which may be important for your research questions while also remaining open to the unexpected. Example dimensions are mindfulness (Weick, Sutcliffe, & Obstfeld, 1999), heedfulness (Weick & Roberts, 1993), loose/tight (Granovetter, 1973; Papa, 1990), quantity (Kauffman, 1995; McKelvey, 1999), and quality of connections (Daft, 1989; Thompson, 1967). When we use complexity science, we need to have richer understandings of relationships in our case studies. Traditionally, we have looked for rich understandings of the elements in the case. We also must pay attention to the ways in which elements are similar to or different from each other. This means that we must pay attention to system diversity on a wide variety of dimensions (not just race and gender) and try to understand how that diversity might help the organization and how it might hurt the organization (McDaniel & Walls, 1997).

  For example, building on the nursing home case example above about the crying patient, the registered nurse (RN), holding a clinical mental model of the patient’s behavior (crying, not eating, taking to the bed) would likely have considered it a symptom of depression. Thus, had the RN been aware of the patient’s behavior, she would have investigated to see if it was possible to rule-out depression as the primary cause of the observed behavior. However, there were several barriers to the RN detecting this issue. First, sparse interaction occurred between the RN and nurse aides and hence the RN was not likely to just stumble onto the relevant information. The nurse aides, while they would report certain things such as an elevated temperature, did not report this behavior because it was clear to them that it was a behavioral issue that they could manage without bothering the nurse—a concern expressed by the nurse aides that caused them to censor their interaction with the nurse. Finally, the RN does not recognize interdependency between her role and that of the nurse aides and thus did not actively seek out what the nurse aide “knew” about the patient. In this study, the researchers observed that the two types of workers (nurse and nurse aide) held very different mental models of the patient’s behavior. Because of the nature of the relationships in the nursing home, the diverse views were never explored together leading to a potentially poor outcome for the patient. In

this case study design, the researchers stated the goal of understanding the nature and quality of connections among agents, however when the analysis revealed aspects of mindfulness (connection between thought and action), this dimension was added. Relationship patterns were assessed through direct observation of multiple processes (e.g., shift change reports, care planning meetings, direct care routines), shadowing the nurse aide and the RN while they worked, and through depth-interviews where explanations were obtained from the agents about their actions and thought processes.

- **Focus on nonlinearities**

  It is difficult to detect nonlinearities. Therefore, try to look for instances where small events have led to large outcomes. For example in one of the nursing home case studies, a patient's daughter had a habit of leaving post-it notes stuck all over the patient's room with instructions to the nurse aides about things such as laundry, placement of personal items, and meal preferences. Rather than seeing the notes as useful information for the patient's care, the nurse aides were highly insulted and viewed the action as the daughter trying to be "the boss" of the nurse aides. Significant staff time (multiple levels of managers as well as nurse aides) was invested in talking about the issue and meeting with the daughter to try to get the daughter to stop posting notes. The issue became so disruptive that it was suggested that the patient find another nursing home. Thus, the daughter's seemingly "small" act of leaving notes to the staff resulted in a disproportionately "large" outcome of the daughter being asked to move her mother to another nursing home.

  In contrast, examine nonlinearities by looking for instances where large events have led to small outcomes. A one nursing home in the nursing home case study, for example, turnover of the nursing home administrator was a seemingly large event (i.e., it occurred three times in just over a year) but seemed to have a disproportionately small impact on the nursing staff working on the patient units. The staff's explanation was that they could and would outlast any administrator, and thus had developed a resistance to change efforts of each new administrator. Why bother doing what he wants when he'll be gone soon?

  Because nonlinearities are keys to understanding the system the researcher must be paying attention in ways that they will be noticed. The case study method allows such nonlinearities to be explored.

- **Look for the unexpected**

  We must ask ourselves what potentially useful behaviors, processes, and outcomes are we missing because we were only looking for outcomes we had predicted? Heisenberg's Uncertainty Principle demonstrates in experiments that when we measure one aspect of matter, other aspects are less observable. "Matter's total identity (known as a wave packet) includes potentialities for [two] forms—particles and waves….We can measure position, and thus get a fix on the particle aspect; or we can study momentum, and observe the wave. But we can never measure both simultaneously" (Wheatley, 1992, p. 35). This suggests that research intended to understand how health care organizations evolve successfully will need to use multiple lenses (methods) to observe it from more than one position and time period. The case study method lends itself to multiple lenses across time. For example, multiple lenses can be used by observing and interviewing people at all levels of the organizations (e.g., patients, nurse aides all the way to the top administrator) and across disciplines (e.g. nursing, food service, social services, housekeeping) asking about the same phenomena. The case method is particularly useful in identifying the unexpected because the researcher is in the field and can ask the agents what about the system has surprised them or caught them off-guard, providing new targets for understanding the system dynamics. Traditionally research has focused on average behavior and thus other events (including unexpected events) are considered

anomalous and outliers to be ignored. Complexity theory, however, suggests that it may be fruitful to pay greater attention to outliers because they may be a source of new structural arrangements and patterns of behavior. Thus, in choosing cases for comparison, it is often useful to look to the extremes—comparing the very best with the very worst (Anderson, Hsieh, & Su, 1998).

- **Examine unexpected events**

  Deeper understanding of the organization can be gained by a search for actions taken in the organization that deviated from the "plan." Successful organizations are often those in which people are attentive enough to improvise—that is deviate from plans or routines—when events suggest that some new or different behavior is needed (Eisenhardt & Tabrizi, 1995). One of the ways that people treat the unexpected is to normalize it (McDaniel et al., 2003). The case study researcher therefore must be careful not to accept explanations that normalized something that initially was unexpected. For example, engineers called the failure of the o-ring on the Challenger space shuttle the normal way that the o-ring behaves rather than a potential source of disaster (Vaughan, 1996). The case study researcher must see disruptions in the state of the systems as an opportunity rather than a distraction or barrier to the research. Be sure to try to detect the nature of the organization's response to uncertainty. In particular, to what extent do they try to control uncertainty versus leverage uncertainty and what strategies do they use? Look for examples of creativity (Guastello, 1995; Jones, 1997; Stacey, 1992), improvisation (Brown & Eisenhardt, 1997; Crossan, 1998) and bricolage (Weick, 1993a), as well as rules, policies and procedures. Complexity science suggests that rules have less relevance than we traditionally thought while creativity has more relevance than traditionally thought.

- **Focus on processes as well as events**

  Case studies traditionally search for decision points as major events for revealing the nature of the organization. Complexity science suggests that you should look instead for sense making properties as revealing the nature of the organization (Weick, 1995). Pay attention to sense making as a process not just decision making as an event. Complexity sciences ask that we focus on processes. In the example above, if the researchers had not explored the sense making process of the nursing aides, links between thought (child care/rearing guiding mental model) and action (timeout) would not have been revealed and a potential conclusion for the event might have been that the nurse aides were thoughtless and cruel. Instead, much richer patterns were revealed with better potentials for intervention. Researchers usually try to understand what an organization knows, but from a complexity viewpoint, we are more interested in how an organization learns. For example, how are errors treated (Edmondson, 1996)? How are samples of one turned into learning opportunities (March, Sproull, & Tamus, 1991)? What is the balance between exploration and exploitation (Levinthal & March, 1993)? Treat conflict in the organization as part of the routine ebb and flow rather than as a disruptive event (March, 1958).

- **Recognize dynamics**

  Self-organization and emergence are ongoing dynamic properties of organizations. You must not let the formal organizational documents and policies mask the nature of the organization, which is defined by the informal organization. The organization, thought of as a verb rather than a noun (Weick 1993b), is not something that is; it is something that is becoming. Applied to health care organizations, the concept of emergence will draw the researcher's attention to such things as the "informal" organization. The informal organization is emergent because it is defined as "spontaneously occurring organizational events, structures, processes, groups, and leadership that occur outside of officially sanctioned channels" (Goldstein, 1999, p. 65). Complexity theory is a guide to learning about the ways in which the informal organization

evolves and the adaptive functions (or destructive functions) it performs for an organization. Other emergent phenomena in health care organizations might include leaders that emerge in work groups and the unexpected configurations of health care networks that have emerged through mergers and/or acquisitions. The case study method is well suited to recognizing dynamics because the method facilitates exploring the informal organization. In particular, using strategies of participant observation of agents' interactions and processes, the dynamics of the informal organization will quickly emerge.

Within the case study, the use of social network methods (Borgatti, Everett, & Freeman, 1999) is a strategy for measuring actual communication flows that occur, whether they result from formal or informal mechanisms (Morrissey et al., 1994). Thus, these measures may assist in describing relationship patterns. Relationships represent the ways in which work is carried out and are the conduits for understanding what is to be accomplished. Also, network analysis methods can characterize these patterns for each person in an organization and for the organization as a whole. For example, network analysis can assess: 1) the nature of new information flows through an organization; 2) the density and intensity of those flows (Bovasso, 1996); 3) how monopolized or centralized those flows are (Rowley, 1997); and 4) the extent to which a small number of groups comprising cliques of individuals can keep information from diffusing through the organization, creating fragmentation (Cott, 1997). These measures are just a few examples of how organizations and individuals can be characterized in terms of actual social processes.

- **Describe patterns as well as events**

Research observations that target patterns of relationships, interactions, and processes, over time, are keys to understanding a system (Capra, 1996; Lee, 1997). A search for patterns implies attention to the flow of behavior within organizations rather than merely describing static behavior (Camazine et al., 2001; Goldstein, 1999). As an example, when one enters a particular nursing home, invariably it is apparent that it belongs to the class of organizations called nursing homes and not to the class of organizations called family practices. Nursing homes have regularities in their characteristics that make them recognizable as nursing homes. Despite such macro-level regularities, however, internal processes differ significantly from organization to organization (Tallia et al., 2003). Particularly important patterns are likely to be found in the relationships among people in the organization and the ways they interact (Watts, 2003). In the nursing home case study example above, describing the pattern of relationship between the nurse aides and the RN provided important information for understanding the event (i.e., the timeout). By using the case study methods with attention to relationship patterns, results were richer and provide more avenues for potential intervention.

- **See patterns across levels**

Complexity theory suggests that a health care organization is best understood as a system and that a system is best understood as nested within of a larger network of systems (Watts, 2003). The same holds true for individual people or units within a health care organization. There is likely to be a fractal (Liebovitch, 1998) or self similar set of relationships between phenomena at different levels of the organization. The example above in which the surveyors were making surprise visits to the nursing home, finding fault and making citations is a macro-level pattern that is similar to the pattern at the subsystem level in which the managers were making frequent rounds, finding fault with staff behaviors and making corrections. Case studies can be designed to look for this self-similarity in analyzing patterns.

- **Understand that patterns change**

Traditional case study research design seeks to identify trends and trajectories. Case study designs using a complexity science blueprint will also seek to discern patterns in the behaviors

and would recognize that the patterns themselves may well change over time. For example when doing a case study to help understand nurse behaviors and the pattern of pain medication, it is useful to examine patterns of use across patients rather than the individual use by a patient. We might find that patients who have advocates might have a different pattern of pain medications use than those who don't have advocates.

- **Recognize that in any given situation different patterns may be successful**

  Because the nature of a complex adaptive system emerges through self-organization and has the property of equifinality (Knight & McDaniel, 1979), when more than one case is studied, more than one successful configuration is likely to be found. In health care, much value is placed on identifying and disseminating "best" practices. Complexity theory suggests, however, that there may be more than one way for organizations to be successful. In research, if we seek that one best answer, we will probably find it. Research that is open to more than one way of looking at situations however will lead to more useful knowledge. There is likely to be more than one successful process, structure, or configuration of processes and structures (i.e., patterns of organization) within any complex adaptive system. Because case studies are designed first to describe the uniqueness of each case, it is a method that is suited to finding multiple successful patterns.

- **Shift foreground and background**

  Creating new views of organizations is a key to a better understanding of them. Using a model with boxes and arrows as a metaphor for shifting foreground and background, Lissack (1999) describes the organizational chart as a model of boxes with lines between them. He suggests that traditionally we put most import on the boxes, which define roles and formal organizational position. Shifting, however, and placing most import on the lines between the boxes will bring to life the "relations, flows and exchanges" (Lissack, 1999, p. 120) represented. The case method can facilitate shifting foreground and background multiple times during a research study. For example, examining the system with the patient at the center will reveal certain issues and then shifting and examining it with the physician at the center will reveal other issues that are most likely linked to the patient issues through system processes. Shifting foreground and background is another way to change the lens used to study the same phenomena.

- **Redefine observer roles**

  Treat the case study researcher as an intruder who is providing an opportunity to observe how the system dynamic unfolds as it adapts to that intruder. This idea goes beyond the idea of research rigor in which reflexivity and relationality are addressed through "attention to making the effects of interactions of investigators and participants more transparent during data collection and analysis" (Hall & Callery, 2001, p. 270). It suggests that responses to the researcher or research process can provide considerable information about the nature of the system itself. For example, in a nursing home case study introduced above, one of the team members interviewed the medical director about practice guidelines used in the nursing home. He indicated that they were not currently using them and had not previously considered using them. Soon after, when the researcher interviewed the nurse about practice guidelines, the nurse indicated that the medical director had just suggested that using practice guidelines might be a good idea. Thus this system responded to ideas introduced by the investigators, which could be a distinguishing factor for this nursing home if others in the study do not demonstrate uptake of ideas in this way.

  Recognize also that because of the coevolutionary nature of complex adaptive systems the role of the observer changes over time as a result of the fact that the system changes and the system

changes as a result of the observer's presence. Observing these coevolutionary changes is a rich opportunity for gaining insights into system dynamics.

- **Learn the system's history**

  What the health care organization is today is in large part due to what it was yesterday. In complexity theory, this phenomenon is referred to as interdependency of present and past. Thus learning how the system has evolved over time will provide insight into its present patterns of behaviors. Take for example the case study (described above) in which the nursing home is playing out patterns that are linked to its history of very poor survey results. In describing the system's history, significant events are important. But true understanding of the system will come from describing its configuration of relationships over time (Capra, 2002; Stacey, Griffin, & Shaw, 2000). Using the case study method, this suggests studying how managers and staff have historically related to each other within the organization and to people outside the organization. Additionally, it suggests exploring what types of relationships have been most intense, relied on in crisis, or relied on when thinking about what to do next.

SUMMARY

Choosing a case study approach moves us one step closer to being able to study a phenomenon as an integrated whole. To most people, studying something as an integrated whole appears to be a daunting task. Questions arise, such as, what is it about the system that makes it an integrated whole? How does one describe the whole without pulling it apart? What are the characteristics and/or properties that make this a system as opposed to something else? Complexity theory provides some clues as to how to answer these questions and, if used in planning, executing and interpreting in case studies, can serve as a guide to understanding the system of interest as an integrated whole.

Historically, case studies have been viewed as most useful when little is known about a phenomenon, often as a first step in developing knowledge, and as least useful when much is already known about a phenomenon and theory testing is a research goal (Yin, 1994). Our view that the case study strategy can contribute appropriately at any level of knowledge development is consistent with many advocates of case study such as Eisenhardt (1989) and Yin (1994). That is, the case study strategy could be the appropriate approach for exploratory, descriptive, or explanatory purposes. Recently, Kairys et al. (2002) used the case method for purposes of explanation and in the same study for actively changing medical practices in a form of participatory research. The literature contains examples of case study being used for each of these levels of knowledge development. For example, case study has been used to describe processes (Lawrence & Hardy, 1999), generate theory (Brown & Eisenhardt, 1997; Gioia & Thomas, 1996), and test theory (Johnson, Leach, & Liu, 1999; Sambamurthy & Zmud, 1999). Thus, a key to knowing when to use case study as opposed to another approach does not lie solely in how much research has already been done and how much is known for explaining a phenomenon. Rather a key to knowing when to use case study lies in the nature of the research purposes.

The case study approach provides us with a strategy for studying integrated systems. Complexity theory is a useful companion to case study because it simultaneously fosters an attitude of attention to emerging patterns, dynamism, and comprehensiveness while focusing attention on defined system properties. The theory suggests that the keys to understanding the system are contained in the patterns of relationships and interactions among the system's agents (Capra, 1996; Lee, 1997). As such, complexity theory provides us with a place to begin the daunting task of studying a health care system as an integrated whole.

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Table 1

Key Characteristics of Complex Adaptive Systems

Agents

People, human processes such as nursing processes, medical processes, administrative processes, and computer systems are examples of agents. Agents have the capacity to exchange information with their environment and as a result adjust behavior. The more diverse the agents, the more likely it is that novel behavior will result from information exchanges (Cilliers, 1998; McDaniel & Driebe, 2001).

Interconnections

Agents interact

Agents interact and exchange information through relatively rich means (Cilliers, 1998), creating connection among all agents in the system (Capra, 2002; Kauffman, 1995).

Interactions are local, patterns are global

Although agents interact only locally, these connections ensure that local interactions can spread information rapidly throughout the system (e.g., rumor mill) and also that a single agent can influence many agents through a network of connection. Interactions at the local level give rise to global patterns (Casti, 1994; Cilliers, 1998). Because agents interact only locally, no single agent knows the system as a whole (Cilliers, 1998). Complexity emerges from the patterns of interaction among the agents.

Interactions are non-linear

Interactions are non-linear, meaning that small “causes” may have large effects and large "causes" may have small effects (Axelrod & Cohen, 1999; Capra, 1996, 2002; Kauffman, 1995).

Self-Organization

Self-organizing is the process by which people mutually adjust their behaviors in ways needed to cope with changing internal and external environmental demands (Cilliers, 1998). Self-organization arises because agents are interrelated and interdependent and because they have “freedom to interact, align, and organize into related configurations” over time (Lee, 1997, p. 20). Thus agents self-organize to create the new structures and behaviors needed to meet the demands of the relationships they have with each other and the environment (McDaniel & Driebe, 2001).

Emergence

“Agents interacting in a nonlinear fashion may self organize and cause system properties to emerge (McDaniel & Driebe, 2001, p. 19).” However, the emergent properties of the whole are distinct from the properties of the agents (Capra, 2002; Holland, 1998; Johnson, 2001). For example, understanding the quality of care delivered by individual nurses in a nursing home may not give deep insights into the overall quality of nursing care in the home.

Co-Evolution

Complex adaptive systems are open, and thus agents interact with others in the environment extending the interactions and information exchanges beyond the system boundaries (Boisot & Child, 1999; Camazine et al., 2001; Stacey, 1995). Both the complex adaptive system and world around it change through these interactions. Because of co-evolution, the system’s current and future behavior is intricately linked to its history (McDaniel & Driebe, 2001).