

Complexity Science: a Worldview Shift

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One of the frustrations of working in the exciting area of “complexity science in organizations” is that there is no commonly accepted definition of what this term means (White *et al.*, 1997). Definitions have been offered, such as “complexity is a watchword for a new way of thinking about the collective behavior of many basic but interacting units ... complexity is the study of the behavior of macroscopic collections of such units that are endowed with the potential to evolve in time” (Coveney and Highfield, 1995: 7). Although this definition is very descriptive, it still seems general and unfocused. The purpose of this article is to offer a simple definition for complexity science and to demonstrate the shift in worldview necessary for complexity science to become second nature to people as traditional science now is.

Simply put, *complexity science is an approach to research, study, and perspective that makes the philosophical assumptions of the emerging worldview (EWW)—these include holism, perspectival observation, mutual causation, relationship as unit of analysis, and others; see Table 1. Classical science, as practiced in the twentieth century, for the most part makes the philosophical assumptions that will be labeled here the traditional worldview (TWV)—which include underlying assumptions of reductionism, objective observation, linear causation, entity as unit of analysis, and others.*

This TWV, which has allowed people to make significant achievements in many fields, is no longer serving as a reliable guide. Several

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brief examples illustrate the dysfunctional nature of TWV assumptions applied inappropriately:

- ◆ Rent control laws that were intended to maintain a stock of low-cost housing have resulted in a shortage of low-cost housing.
- ◆ The demise of the *Saturday Evening Post* and the Curtis Publishing Company has been attributed to “management essentially look[ing] for short and direct cause and effect linkages” (Jacobs and Jaques, 1987: 34). Computer simulations have suggested that this company could have been saved if a strategy incorporating complex, indirect linkages had been employed.
- ◆ “The largest building in the world, the space vehicle preparation shed at Cape Kennedy, generates its own weather, including clouds and rains. Designed to protect space rockets from the elements, it pelts them with storms of its own” (Gall, 1977: 20).
- ◆ Sick people go to the hospital to be made well. Twenty percent of all patients, however, *acquire* illness in the hospital as a result of their diagnostic procedures and treatments prescribed (Illich, 1977: 23).

The rise of complexity science has paralleled an increase in dissatisfaction with the TWV. Capra (1982: 15) labels this dissatisfaction a crisis of perception and says that it occurs when people hold to a mental model that no longer achieves their standards of accuracy. Other writers have called this same phenomenon a period of dislocation (Ackoff, 1981) or a time when we are between “stories” (Schwartz and Ogilvy, 1979). We do not yet know exactly what the new story will be. It is easier to see where we have been than where we are going. Consequently, the problems and dilemmas that have arisen are easier to critique than the specific details of a new worldview are to provide. Examples of these difficulties are TWV assumptions that work within a range of conditions, but beyond that range they no longer work.

Many have written about the change in worldview (Wishard, 1995; Dooley, 1997; Slife and Williams, 1995; Smith, 1982; Ackoff, 1994; Dent, 1995). In contrast to these works, however, the focus of this article is on the change in thinking that is required for organizational members to function effectively in postmodern organizations. I will suggest that if we are to continue to grow, develop, and thrive in this world we must adjust some of our most deeply held mental models about the world and our interactions with it. At the same time, I acknowledge that there is some suggestion (Wilber, 1998) and evidence (Dent and Powley, 1999) that the

worldview shift may not be progressing as rapidly as some writers have claimed. The article will attempt to describe the most necessary shifts in thinking so that complexity science will be seen as “normal.”

Some of the underlying assumptions of the shift in worldview are becoming clearer. A difficulty in capturing the TWV and EWV underlying assumptions, though, is that the worldviews cannot be simply stated. One can use simple metaphors like the clock and the waterfall, but these do not capture the full essence of the worldviews. Table 1 contains a list of a number of differences in underlying assumption gathered from a variety of sources.

Most readers of this article will have been taught in a learning paradigm so that they will be more comfortable with the information presented in the form of Table 1 (Vaill, 1996). However, Figure 1, which still has limitations, is a more accurate visual representation of the differences in TWV and EWV underlying assumptions, for reasons discussed below. Including all of the information in Table 1 in Figure 1 would overwhelm the visual representation, so only the three constructs that best differentiate worldview (Dent, 1997) are presented. For clarity of understanding, the word “construct” is used to denote a phenomenon such as causality. The word “assumption” is used to indicate a selection within a construct. So, for the construct causality, the two assumptions labeled are mutual and linear.

TAKING THE TRADITIONAL WORLDVIEW “OUT OF RANGE”

It is important to note that theorists are not suggesting that the traditional underlying assumptions are wrong. In fact, many of them seem to be useful in localized settings. For example, Prigogine and Stengers (1984: xxiii) see determinism and indeterminism not as irreconcilable opposites but “each playing its role as a partner in destiny.” Between bifurcation points, determinism is operative. At a bifurcation point, however, indeterminism takes over. Consequently, indeterminism (which doesn’t dismiss localized determinism) and the other emerging assumptions seem to be more useful abstract concepts. They reflect reality more accurately in a larger number of instances. Capra (1982) nicely captures the distinction:

Modern science has come to realize that all scientific theories are approximations to the true nature of reality; and that each theory is valid for a certain range of phenomenon. Beyond this range it no longer gives a

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Table 1 *Emerging and traditional worldview descriptors*

<i>Emerging</i>	<i>Traditional</i>
Holism	Reductionism
Mutual causality	Linear causality
Perspectival reality	Objective reality
Observer in the observation	Observer outside the observation
Indeterminism	Determinism
Equal focus on exteriors and interiors	Primary focus on exteriors (Wilber, 1998)
Adaptive self-organization	“Survival of the fittest”
Adaptive self-organization	“Lead or seed” (Resnick, 1994)
Focus on relationship between entities	Focus on discrete entities
Dialogical research methods	Monological research methods (Wilber, 1998)
Nonlinear relationships	Linear relationships
— Critical mass thresholds	— Marginal increases
Polarity thinking	Either/or thinking (Johnson, 1992)
Focus on feedback	Focus on directives
Quantum physics perspectives	Newtonian physics perspectives
— influence occurs through iterative non-linear feedback	— influence occurs as direct result of force exerted from one person to another
— the world is novel and probabilistic	— expecting the world to be predictable
Postmodern	Modern
Dedifferentiation	Differentiation
Focus on heterarchy (within level)	Focus on hierarchy (between levels)
Understanding/sensitivity analysis/explanation	Prediction
Equality	Patriarchy
Yin/yang balance	Yang dominance (Fondas, 1997)
Language as action (Gergen and Thatchenkery, 1996)	Language as representation
Paradox	Logic
Based on biology	Based on nineteenth-century physics
— structure, pattern, self-organization, lifecycle	— equilibrium, stability, deterministic dynamics
Focus on patterns	Focus on pace (Bailey, 1996)
Focus on variation	Focus on averages
Local control	Global control
Behavior emerges from bottom up	Behavior specified from top down
Metaphor of morphogenesis	Metaphor of assembly
Focus on ongoing behavior	Focus on results or outcomes
Generalist	Specialist
Little or no transference of models	Easy transference of models
Theory is narrowly applicable	Theory is widely applicable
Irreversible time	Reversible time
Generation of symbols	Transmission of symbols
Mind creates matter	Matter creates mind (Harman, 1998)

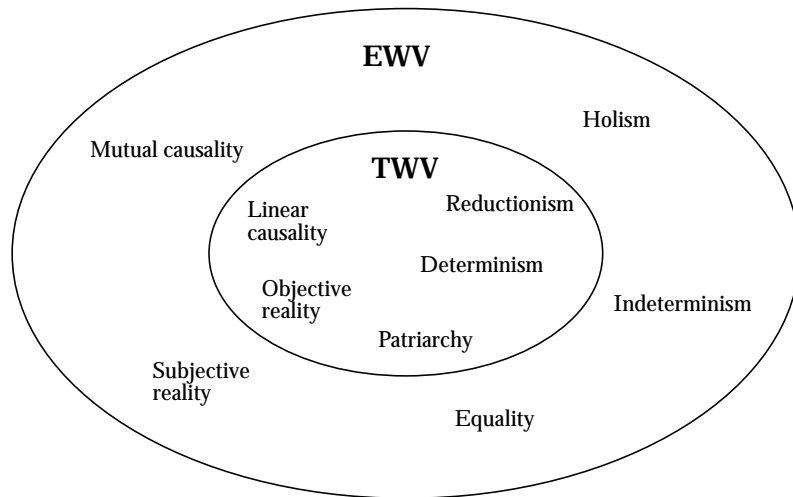


Figure 1

satisfactory description of nature, and new theories have to be found to replace the old one, or, rather, to extend it by improving the approximation. (Capra, 1982: 101)

A clear example is the set of equations that Newton developed for the movement of celestial bodies (Briggs and Peat, 1989: 27). Newton's work results in precise solutions when only two bodies are involved, for example the moon and the earth. If a third body, such as the sun, is added, the equations become unsolvable. Even if the third body is extremely small, its minute gravitational pull "might cause a planet to wobble and weave drunkenly in its orbit and even fly out of the solar system altogether" (Briggs and Peat, 1989: 28). To determine accurate planetary movements, the researcher is left to develop a series of approximations using heuristic techniques.

Ken Wilber (1995) uses the term "fractured worldview" to describe the part-right, part-wrong feature of the TWV:

The problem was not that these early conceptions were simply wrong. Aspects of the physiosphere do indeed act in a deterministic and mechanistic-like fashion, and some of them are definitely running down. Rather it was that these conceptions were partial. They covered some of the most obvious aspects of the physiosphere, but because of the

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primitive means and instruments available at the time, the subtler (and more significant) aspects of the physiosphere were overlooked. (Wilber, 1995: 10)

Wilber's primary complaint is that the TWV ignores the internal world of prehensions, sensations, perceptions, impulses, emotions, images, symbols, and other similar phenomena that many would argue constitute as important, if not more important, a part of life.

Problems also arise when people assume that the TWV is accurate in all settings. Although it is inappropriate, and potentially inaccurate, researchers frequently use linear regression on non-linear phenomena, calculus on discontinuous functions, or chi square when data points are interdependent (Dent, 1994). Priesmeyer (1992: 30) has speculated that traditional statistical methods remain useful for systems that are nearly stable. Classic problem-solving techniques make perfect sense when reductionism can be assumed. If a single problem can be solved completely independently of everything else in the system and its environment, problem solving is an ideal strategy. However, when interdependencies are present, problem solving becomes less effective.

The comprehension and control model of management makes perfect sense in a relatively stable environment. However, the Relaxation Time Principle has shown that "system stability is possible only if the system's relaxation time is shorter than the mean time between disturbances" (Clemson, 1984: 213). In other words, if an organization experiences changes more rapidly than it can comprehend and control them, then it is not possible to keep the system stable. A similar example is provided by Karl Weick (1985: 110). He describes the decision-making style of the TWV as rational. Rational decision making is effective in organizations in environments that change slowly, have few social groups, and have centralized authority that works reasonably well. Weick observes that these conditions are now relatively rare in organizations.

Consequently, some aspects of the EWW are simply "enlargements" of the TWV. McKelvey (1999) notes that

since the [EWW] does not require axiomatic reduction, it tolerates multiple models. Thus, "truth" is not defined in terms of reduction to a single model. ... That they also have different theoretical explanations is not considered a failure. Each is an isolated, idealized physical system representing different aspects of real-world phenomena. (McKelvey, 1999: 19)

Perhaps the most useful mental model for thinking about the TWV and EWV is that of a polarity (Johnson, 1992). Polarities are sets of opposites that cannot function well independently. The two sides of a polarity are interdependent, so one side cannot be “right” or the “solution” at the expense of the other. Johnson contends that “many of the current trends in business and industry are polarities to manage, not problems to solve” (p. xi). An example of a polarity in worldview is that, rather than replacing yang dominance with yin dominance, the EWV includes a balance of yin and yang, not subordinating the yang. Likewise, the example provided earlier suggests that indeterminism and determinism form a polarity. The question of behavior emerging from the bottom up or being imposed from the top down form a polarity.

Each side of the pole has upsides and downsides. A “figure 8” pattern often develops between the upsides and downsides of the two assumptions. People often identify the downside pole as the “problem” and therefore want to abandon it. The upside of the opposite pole is seen as the “solution.” When one pole has been emphasized for too long, the result is the downside of both poles. In terms of polarities, the shift called for in this article is from a focus on a single pole (the TWV) to a focus on both poles (the EWV). A graphical representation of a polarity is depicted in Figure 2.

Although a juxtaposition listing such as Table 1 earlier may create this implication, because of instances of synthesis and polarities, these differences should not be pictured as a continuum with the TWV at one end and the EWV at the other. It is more accurate to say that there is a complementarity in the items. In some cases, one is an enlargement of the

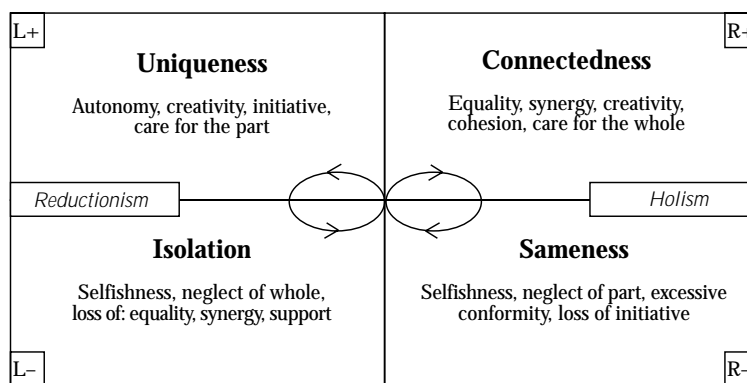


Figure 2

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other, in some they are primarily distinct, and in others there is some overlap.

It is also important to recognize that a breakdown in the TWV does not automatically mean the ascendance of the EWW. A manager, for example, could be totally frustrated by hierarchical structure but not know with what to replace it. And, if we give up a belief in survival of the fittest, we do not necessarily embrace adaptive self-organization. In this case, there are other alternative concepts about structure.

ORGANIZATIONAL PHENOMENA BASED ON EWW ASSUMPTIONS

In *The Fifth Discipline*, Peter Senge (1990) includes mental modeling as one of the five disciplines. He suggests that people must be able to surface mental models by sharing the assumptions they make in a situation. This task is not trivial. Most mental models are so deeply imbedded that people do not even realize they are simply models; we believe that they are reality.

Mental models are critically important. How we see things determines much of what we see. Consequently, a change in worldview from TWV to EWW would result in major changes in how organizational activity occurs. In this section we will include three examples, one for each of the underlying assumptions that best differentiate worldview: mutual causality in strategic planning, holism in mess management, and perspectival observation in performance appraisal.

MUTUAL CAUSALITY IN STRATEGIC PLANNING

Organizations often assume linear causality. For example, a housing organization that institutes rent control expects the direct result to be low-cost housing. Such officials have not realized the feedback from such a policy. This feedback consists of developers who will refuse to build additional housing units subject to rent control, landlords who are forced to allow properties to deteriorate because of below-market compensation, and apartment dwellers who may refuse to move to a location with better job opportunities because of the desirability of such low-cost rent. As in this example, when organizations unrealistically assume linear causality, their policies often bring about exactly the effects against which they were trying to guard (Begun, 1994: 330).

An organization that fully comprehends the effects of mutual causality will engage in strategic planning in a way completely different from

traditional approaches. Mark Michaels (1994: 17) has pointed out that the strategic planning process as typically implemented “involves predictions about future events, predictions which the dynamic of sensitivity to initial conditions—the butterfly effect—prove unreliable.” Karl Weick advocates “real-time” (or just-in-time) strategic planning. He argues that acting should precede planning because by acting we take part in constructing the environment. The environment is not “out there,” separate from us. We can help to create the environment. Weick contends that “we create the environment through our own strong intentions” (Weick, 1995). The Spanish have a phrase which nicely captures this connotation: “*Compañero, no hay camino. Se hace camino al andar.*” A suitable translation is: “My friend, there is no road. You make the road as you walk.”

Michaels incorporates the idea of feedback by noting that a strategic plan should be a statement of purpose, “of the company’s moral response to its broadly defined responsibilities, not an amoral plan for exploiting commercial opportunity” (1994: 17). This perspective honors the multiple sources of interconnections that develop over the lifetime of an organization. Weick and Michaels place much more of an emphasis on the present than traditional strategic planners do. Michaels even highlights the importance of the past. His three-step process of strategic planning is (1) creating a shared past; (2) defining the present; and (3) steering into the change.

This view of strategic planning is very different from the traditional process that includes developing a vision, a mission, identifying stakeholders, and doing a SWOT (strengths, weaknesses, opportunities, and threats) analysis. This type of analysis assumes that the environment presents opportunities and threats, not that the organization is an active player in creating opportunities and/or threats. Priesmeyer (1992) adds that the traditional strategic planning model is inaccurately simplistic because it “suggests that one can understand the state of the system by assessing current conditions, when in fact an understanding of evolving conditions is important” (Priesmeyer, 1992: 195).

THE TRADITIONAL
STRATEGIC PLANNING
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SIMPLISTIC

HOLISM IN MESS MANAGEMENT

Perhaps the most radical example of holism in practice in organizations is Ackoff’s call for an end to problem solving. Ackoff contends that many of the problem-solving approaches used in organizations are not effective. His argument is similar to that of Senge’s designer role for leaders. Senge

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(1990) believes that problems should be prevented by proper design. Ackoff would not argue with that, but would add that when anomalies do occur, they should be managed as part of the regular course of things, rather than having a taskforce convened, or an employee assigned to work on a particular problem. According to Ackoff:

this whole way of thinking encourages us to focus attention upon bits and pieces of our organizations and thereby leads us to adopt policies and carry out actions that as often as not make the original situation worse. (Clemson, 1984: 171)

It is rare in organizations that a problem can be isolated so that a fix can be implemented without also altering something else in the organization. Ackoff advocates “mess management,” his term for the continuous balancing and navigating of complex, interrelated messes, rather than problems, that most people in organizations face.

Ackoff lists several problems with problem solving. For example, in many cases the complexity of the problem exceeds the problem-solving expertise of lower-level employees often assigned to “tiger” teams, taskforces, or other-named *ad hoc* problem-solving groups. Also, assigning a taskforce to study a problem and recommend a solution assumes that while the taskforce is spending time working on the problem, the problem is not changing (Ackoff, 1981: 4–5). Anyone who has worked in an organization has had the experience of a tiger team coming up with a recommended solution that is not ultimately implemented. Ackoff would suggest that the primary reason is that the tiger team did not take into account the whole—the complete set of interdependent relationships within a given executive’s purview. Mess management requires the executive, who has the responsibility for handling all of these interdependencies, to manage any problems that arise within his or her natural, normal processes.

PERSPECTIVAL OBSERVATION IN PERFORMANCE APPRAISAL

In our research, we have discovered that the English language contains a number of rich expressions that convey an appreciation of perspectival observation. These include: where you stand depends on where you sit, beauty is in the eye of the beholder, everyone looks at the world through his own glasses, the glass is half-empty or half-full, a self-fulfilling prophecy, it’s the blind man and the elephant, the Rashomon phenomenon, the umpire training school joke about “the pitch ain’t nothin’ until I

call it," and that there are two sides to every story. Such a broad set of common expressions would lead one to believe that perspectival observation is a widely held assumption in society. Paradoxically, our research and experience within organizations has been the opposite. We have interviewed individuals, for example, who were perfectly willing to accept perspectival observation about what happened at an extended family Thanksgiving dinner, but who would insist that at work there is only one true story of what really happened.

The prevailing view of performance appraisals in organizations is based on the assumption of objective observation. This dominant TWV is expressed in statements such as "performance measurement is typically the source of many problems in appraisal because it is seen as subjective" (Cummings and Worley, 1993: 403). Subjectivity is assumed to be problematic. An entire industry, led by the Hay Group, is devoted to instituting objective performance appraisal systems into organizations. In summary, the two forms of objective performance appraisal predominant in organizations today site the objectivity either within the manager alone, or in quantifiable metrics such as number of lines of computer code written, number of academic papers published, or projects completed on schedule and within budget.

Those who assume perspectival observation contend that performance appraisal cannot be objective. For example, for only the simplest of jobs can individuals be given performance objectives that are completely within their control. If the workplace is interdependent, employees are often independently held accountable for the functioning of interdependencies that are operative in the completion of their work. Deming (1986) and the quality experts question objective performance appraisal from another perspective. They argue that it is impossible to define a subset of performance measures that can encompass the full set of behaviors that an organization wants from its employees. (For example, the 1985 and 1986 Florida Teacher of the Year recipients were both denied merit increases under the merit pay program in place at the time. The awards were given because of the teachers' enthusiasm, dedication, involvement with students, and innovation in the classroom. The merit pay formula heavily emphasized factors such as how promptly a teacher begins and ends class.) Empirical research suggests that managers are not capable of reliably evaluating performance over time (Atwater and Yammarino, 1992).

A technique for incorporating the assumption of perspectival observation into the performance appraisal process has recently come in to

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vogue. This technique has been labelled 360-degree job evaluation, multirater performance appraisal, team-based pay, and others. It is based on the assumption that no single person or collection of metrics can best reflect an employee's performance. Many organizations are using this technique only as a way of providing feedback to an employee. The employee's subordinates, however, do not have a say in his or her salary increase or promotion (Antonioni, 1996). Many other organizations do use subordinate appraisals to determine a manager's raises and promotions (McEvoy, 1987). Motorola bases 20 percent of an employee's pay on input obtained from peers. It intends to increase this percentage to 50, and contends that peer review for pay has been a major factor in a productivity boost of 126 percent over seven years (Swoboda, 1994). These multirater techniques suggest that "reality" is best articulated as a collection of a number of different viewpoints.

CONCLUSION

An individual's worldview may be a significant determinant in their success as a practicing manager. Complexity science opens up a whole new vista of perspectives, approaches, and techniques, because it is based on a set of underlying assumptions that differ from classical science. Managers need to adjust their mental models to ones that are more useful in accomplishing work. People have been operating with mental models that have not allowed them to achieve the results they have desired. We as inquirers are changing as observing systems. Just as the telescope and microscope revolutionized the way people constructed reality, the computer is having a similar effect today. These tools of intervention are our new sensory organs. Our reality changes as our ability to detect phenomena changes.

While the nearly exclusive emphasis of measurement and quantification has resulted in phenomenal knowledge in the past several centuries, we may be near the peak of the mountain represented by the natural phenomena that can be explained by separate and distant inquiry. We may have passed the peak for organizational phenomena. Research is being conducted to determine whether or not worldview distinguishes between successful and less successful managers. Many management education programs need to be changed to teach more holistic, perspectival, and mutually causal mindsets. Although changing mental models is often difficult, such flexibility is necessary in the demanding, global marketplace of today.

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