HOLONIC SYSTEMS MANAGEMENT IN THE FOURTH WAVE

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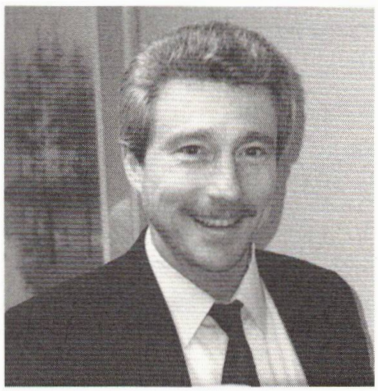

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At the 1964 Worlds Fair in Flushing Meadows, New York, a predominant theme was "Progress is our most important product." The idea of progress had been around since the end of World War II, and for over two decades was the major focus for society and for the business community that was supplying the progress.

But the industries that drove the post-war economy are now mature. They are being displaced by a whole new set of engines of progress: microelectronics, robotics, biotechnics, software systems, and telecommunications. To top this, a genuine global economy has emerged. All the major economies are concentrating investments and financial attention on the new industries.

The structures of our organizations today are under attack, especially that of the hierarchy. The hierarchy is necessary in a "command and control" form of management. Yet, while it is under siege, it remains solidly intact, even as downsizing and reengineering are played out. Teams have emerged as an answer to the empowerment thrust, but have yet to produce the desired performance results.

Rather than a tearing down, I propose an evolving toward a structure of the integration of the part to the whole, the individual to the group, to move to the next level. A structure is needed that can be enfolded on top of any organization (even those that are not hierarchic!) by which leadership and management will be able to plan, develop, and maintain performance, while han-

dling change and renewing itself. This structure will be shown to be holarchic in design, using concepts of control systems from cybernetics. The reformation will need to be both philosophical and operational.

Our organizations are complex. It has become well-nigh impossible in a command-and-control structure to "manage" all the inputs and outputs in any organization and at the same time be expected to produce results that for the most part are beyond the control of the organization. The problem of autonomy versus control has come to the forefront and is taking center stage. Yet when we look at any form of social organization in either the pre- or post-capitalist societies that have any degree of coherence and stability, we find they are hierarchically structured.

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The universal characteristic of hierarchies is the existence of the paradox of the terms *part* and *whole*. A part is considered a sub-assembly, a fragment, an incomplete element, which considered by itself does not have a legitimate existence. A whole, on the other hand, is considered complete in itself and needs no further explanation. But wholes and parts in an absolute sense simply do not exist, either in living organisms or in social organizations. What actually exists are sub-wholes that display simultaneously characteristics of both wholes *and* parts. Managing performance in the knowledge-driven organization will require the understanding of "holarchy." A holarchy is an evolved concept of a hierarchy. Arthur Koestler coined the word "holons" for this concept.[1]

The Fourth Wave

The concept of the "fourth wave" was proposed by Herman Maynard and Susan Mehrtens in a book by the same name.[2] It is a derivative concept of Alvin Toffler's historical wave theory originally propounded in *The Third Wave*.[3] These "waves" are described by Toffler as Agricultural, Industrial, and Information. Toffler says the waves are not as simplistic as the generic titles evoke. The designations portray in a conceptual sense the patterns and forces that shape business, economies, politics, religions, global affairs, and social power interrelationships.

Before Maynard and Mehrtens came along, one only had to extrapolate one's imagination about social evolution to discover that if Toffler's wave theory is accurate and if each wave is behaving as a tighter and shorter bell curve relative to time, then the third wave might very well be cresting *now*. And one would logically ask, just what might take its place in the same way that the industrial age gave way to the information wave?

For well over two hundred years, second-wave societies have looked upon the organization and the individual as totally separate. This dualism—the disassociation of the part from the whole—must be reconciled. The separated parts need to be philosophically and operationally integrated in order to take full advantage of them both. The resulting synthesis creates a structure that can be described as a holarchy. The Universe that we know is structured holarchically, like the Roman god Janus, having two faces looking in opposite directions. One face turned toward the part, the subordinate level, looks like an independent whole, while the face turned toward the superior level looks like a dependent part. This particular structure is evident in all things in the Universe.[4]

For organizations to achieve any form of productivity in the knowledge-based fourth-wave society, principles of open hierarchical systems will have to be addressed.

The overabundant problems we see in society today might be the "chaos" period as waves overlap and create undulating eddies that appear as randomness. In Third World countries, the second wave is alive and kicking, while the third wave is barely being understood in the nations that ought to be its initiators, such as the United States, Canada, Europe, and Japan. For instance, our accounting systems are sadly second-wave based and take in account only hard "smoke stack" assets on the balance sheets. It has been 500 years since Pacioli published his seminal work on accounting, and we have seen virtually no innovation in the practice of enterprise accounting—just more rules, none of which has changed the framework for measuring the information (third wave) society. Old paradigms die hard, even as the new wave is firmly cresting over our heads.

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As information industries (third wave) advance to the extreme mechanization that the agricultural and industrial waves did (first and second wave), the fourth wave will be taking hold in the social fabric. This appears to be inevitable. Recall that in the second-wave affairs, the dominant relationships driving social governance were market focused, and they took precedence over traditional relationships; human worth was measured in commercial terms. At the beginning of the fourth wave, the market sector and government will play a diminishing role in day-to-day affairs. If the employed have more free time because of a shortened work week, while the unemployed have idle time from lack of work, two alternatives would result: increased social unrest and with it the problems of crime and homelessness, or the evolving of the "third sector," which includes community activities, non-profit organizations and advocacy organizations, and

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volunteerism. The social economy is measured in outputs, not salaries or revenue. A new accounting system will take shape as the social economy takes root.

The fourth wave can be extrapolated from Toffler's analysis. It appears to be firmly grounded in Gaia-like concepts that are evolving out of the third-wave society and will have the technological capability to integrate social results with indirect economic gains. The fourth wave can be deemed the *knowledge wave*. Since organizations are structures set up according to a plan that are designed by some person, group, or class for the deliberate and express purpose of achieving certain goals,[5] the conditions for their existence are important and should be considered in any model that attempts to define and predict performance. However, the utilization of the organization as a resource itself is limited by the economic, technical, and political factors surrounding it. The individuals who make up the organization are themselves sources of feedback; motivation and behavior are significant and should be factored in any model.

Abrahamsson has said that organizational theory has three major problem areas. The first is determining how to make the organization efficient, the second is how to satisfy the goals of the mandator, and the third is how to offset the inevitable emergence of bureaucracy. The mandator is the individual or individuals who have taken the initiative to establish the organization and/or have raised funds to purchase the existence. They carry more influence on goals than stakeholders and can have a different slant on effectiveness, in some cases compromising effectiveness and performance and in other cases preventing their compromise. A look at how complex adaptive systems handle this will be instructive.

Complex adaptive systems display the primary characteristics of cooperation, autonomy, and control. The notion of control here is not the same as in the command-and-control sense, but the ability to manage input via feedback and maintain behavior based on a set of patterns (rules) according to thresholds.

Complex adaptive systems have several things in common. First, they exhibit self-management or self-control along with self-creation and autonomy (self-regulation). Second, they are capable of learning through feedback from the environment by embedding experience in their actual structure. Third, they are constructed as open and hierarchical while providing for "flexible specialization." The best complex adaptive system model to make patterns is the human brain. The brain is continually reconfiguring the connections between neurons and dendrites in response to external and internal stimuli, learns through feed-

back, and notwithstanding its triune construction (reptilian, neo-mammalian, mammalian) is completely modularized in areas that specialize in specific functions.

Thus, the kind of structure that, as far as we know, best avoids bureaucracy is one that allows sub-agents to network information paths, to be self-managed but also organized, to respond to feedback and adjust behavior to the environment, to learn from experience and to embed that experience into the structure, and to reap the advantages of specialization without being stuck in rigidity. The above qualities are found in organic, complex, and adaptive systems.

Control

Understanding control systems and cybernetics led directly to concepts of *autopoeisis*—the ability of a living organism to continuously renew itself and to regulate the process in such a way that it retains its structural integrity. Whereas a machine is geared to producing a specific product and its performance can be considered static, a biological cell is primarily concerned with renewing itself as it produces and achieves its short- and long-term goals.

The cybernetic and systems meaning of control concerns the ability to maintain statistical averages (means). A system in control is one that, over an observable period of time, will maintain its performance within upper and lower control limits. Managing systems without knowledge of how the system is performing over time is what Deming calls "tampering."[7] Tampering has to do with the aspect of taking action on a stable system (one in statistical control) in response to "fixing" a faulty output. Acting on a lack of knowledge about the statistical control of a system has a high probability (near 100%) of achieving exactly the opposite of what is intended. By tracing a stable system "upstream," management gets leverage on sources of faults and mistakes. This involves the controlled reduction of common causes in the system.

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Cooperation and Autonomy

The disassociation between cooperation and autonomy have been of paramount significance in the management of organizations. How can one be autonomous and cooperate at the same time? This fundamental problem is one of the primary reasons for the concepts and introduction of holonic manufacturing systems (HMS) in the manufacturing industry. In living organisms the self-organizing, autopoietic tendencies of holons guide the cooperation among holons, leading to a globally near-optimal performance.

In HMS, modeling of the interactions among cells (holons) is being performed without intruding on the individual sub-units' private information and decision autonomy. The modeling uses the object-oriented technologies (C++ and Smalltalk programming languages) that encapsulate data and methods within objects (autonomy) and at higher object levels can clearly delineate the responsibilities and relationships (cooperation).

Likewise, holonic performance management system (HPMS) architectures can be modeled by using whole-part relationships. Contrary to conventional performance management systems, an HPMS is managed in a distributed manner by empowering the autonomy of the system elements or holons. Individual holons define their activities based on their local knowledge and decide their behaviors by cooperation with other holons through their standardized feedbacks. An HPMS would therefore possess the following properties:

1. Modularity. A holon (element) has its local information, decision-making autonomy, and standardized interfaces. It consists of a physical component and information component. The physical component corresponds to physical entities such as individuals, products, or machines, while the information component possesses information, decision-making capabilities, and mechanisms for managing the physical component.

2. Decision autonomy. Decision authority and responsibility are distributed among individual holons throughout the system. Holons are self-sufficient, and possess the capability to create and control the execution of their own plans and/or strategies.

3. Cooperativeness. Individual holons are not expected to operate with absolute autonomy. Rather, they collaborate with other holons to decide their activities, function within the system constraints, and adjust their behavior according to the coordination of feedback.

4. Recursivness. An HPMS consists of holons at various levels; holons at different levels share homologous structure. For example, similar knowledge interfaces, language definitions, and message protocols are needed to ensure cooperation among holons within a level and across levels.

A holon is a node in a holarchy. A holon looks upward for what it needs to cooperate with and integrate with. It looks sideways for what it needs to associate and gain input from (and in some cases may compete with). It looks downward for what it evolved from and wants to command-by-exception. Each holon cannot be fully explained by or predicted by a study of its parts—it is something more. A holon is also part of something bigger

that it is being affected by, but at the same time it has a high degree of autonomy—it has a life of its own.

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Prior to the introduction of cybernetics as a potential management tool, the conventional wisdom for managing cooperation and autonomy was to demand cooperation and limit autonomy. This is just not practical; I have been building the argument for both to exist in parallel.

Hersey and Blanchard proposed a way of handling the dichotomy by coordinating the task structure against the follower's capacity to perform a task.[8] They have defined the need for three systems of control. In Type I, the "boss" controls the activities of the subordinates hierarchically and horizontally as if in a production line environment. In Type II, the boss still controls the activities but task functions are combined. In Type III, which is the least structured, the group members act as separate decision makers and functional units, having the same advantages as the managers in Types I and II, that of direct customer contact.

Using Cartesian methodology, the problems of complexity, rate of change, and interdependency cannot be met effectively. What is needed is a model, a methodology for building the model, and a discipline for providing a general framework.

Because of the embeddedness and incompleteness of each holon, management at best can only partially control the operation and likewise, the operation can at best partially control the environment. This implies and imputes the need for self-regulation. A manager of a system is unable to completely control any system he/she/they are embedded in, simply because they lack the variety to do a complete job. By variety we mean requisite variety from cybernetics; it is the ability of the regulator to achieve control over any situation. Most large organizations clearly do not have the capacity to control all of the aspects of the situation that management is concerned with.

Nevertheless, a group of organizational units needs someone or something to cohere it, to provide it the infrastructure to maintain a separate existence, its viability, its sovereignty, while performing its function and purpose within the larger enterprise. In this context, changes within holons could create negative antagonisms that would need to be resolved via negotiations. This must be accomplished by the next higher-level holon. Thus it is imperative to maintain what the cyberneticians call homeostasis, that is, all critical variables within the system are maintained within normal limits to ensure that the organization functions effectively.

The organization chart that indicates how each part of the business relates to every other part is usually provided to under-

stand all this. What the organization chart lacks, however, is the ability to provide the dimension of control: How will input be optimally converted to output? How will information be transformed into knowledge? In the fourth-wave organization, control has to do with the creation and dissemination of knowledge of an extent and complexity that is beyond the capacity of the boxes (management) to absorb. Thus, the boxes found on traditional organizational charts are not coherent wholes—they are not designed to enable the requirements of autonomous entities. The structural inadequacy in the traditional model of the organization is clear. A new model is required that will actually work as a model. The organization chart did not set out to model the aspects of the enterprise we wish most to understand—the areas that have to do with *control*. Since it is the only model we have had, we insist on using it, albeit inappropriately.

The structural inadequacy in the traditional model of the organization is clear.

Feedback Loops

Feedback provides a system with the ability to be self-regulated. The principle of self-regulation is a fundamental fact of all nonpathological hierarchies. In order to operate within some form of fixed rules, information from the environment must be made available to the system (the organism) based on its progress toward some goal. This progress can be evaluated only against some known and previously set capability.

When the feedback becomes known, the controlling element, or regulator, must constantly adjust the course of the operation. Feedback is generally defined as a coupling of output to input. The current application is known as *cybernetics*.

Many examples of control systems are found in electronic devices, but the most commonly used today is the automobile cruise control. It is designed to maintain a steady driving speed with no assistance from the driver. The interesting thing about this particular control system is that it uses feedback from only one source: the car's speed (technically, from the intake manifold and the first spark plug). This "control" is in contrast to the "control" Beer[9] and Clemson[10] describe, that is, maintaining the critical variables within normal limits to function effectively and maintain homeostasis, exactly like holistic management and holonic-cybernetic systems are designed to do. The cruise control system is designed to control what it senses, not what it does. Thus it controls its *input*, and not its *output*.

But, as Koestler said, feedback without a hierarchy is like a grin without a cat. Feedback doesn't alter the intrinsic patterns of the rule or the process that is already in existence, already decided by the organism.

The cybernetic approach demands that the feedback from the environment merely guide, correct, or stabilize the organism according to some pre-existing patterns of behavior, but a holonic architecture provides for the patterns by which learning can take place. This pattern development can be seen in many ways. For example, after we learn the patterns, let's say to riding a bicycle, the ways by which we keep from falling over while pedaling forward and steering are shaped over time and somehow "burned into" our neurons that move muscles. The constant feedback provided to our eyes, touch, and balance merely tells us when to apply brakes or to turn to avoid a dangerous hole in the road. Given the same exact situation, two individuals would perform differently, albeit homologously. In fact, two individuals would have different levels of threshold by which the message "danger" is sent to the consciousness.

The higher-level system of conscious thought must interrupt the seemingly autonomic patterns of bicycling. Thus the changes in the environment, or the alterations of the external conditions, do not *cause* a process to occur, but modify the process via a higher-level system (holon) in the hierarchy of the organism.

Open Hierarchical Systems

All living matter and all stable inorganic systems have a parts-within-parts structure.

It is abundantly clear that nature is constructed and unfolds/enfolds as an organization of parts-within-parts. All living matter and all stable inorganic systems have a parts-within-parts structure. This structure leads to articulation, coherence, and stability; where the structure is not obvious, the mind provides it. For example, we can project butterflies in inkblots and camels in clouds. This structure is "open" at the top; Arthur Koestler termed these structures "open hierarchical systems." All living organisms and systems are thus open hierarchical systems.

When we look at holons, we observe that holons have dual tendencies. First a holon looks to preserve its identity and then assert it. It seems to act as a semi-autonomous whole. For example, in the body, the heart has a unique identity that can be preserved even if it is transplanted, while performing its functions in relation to the entire body. Second, a holon performs as an integrated part of a larger whole. This duality of behavior is inherent in all hierarchic structures, and is a universal characteristic of life. Ken Wilber has described the evolutional process as a coherent one:

> *All evolutionary and developmental patterns proceed by holarchization, by a process of increasing orders of wholeness and inclusion,*

> *which is a type of* ranking *by* holistic *capacity. This is why the basic principle of holism is holarchy: the higher deeper dimension provides a principle, or a "glue," or a pattern, that unites and links otherwise separate and conflicting and isolated parts into a coherent unity, a space in which separate parts can recognize a common wholeness and thus escape the fate of being merely a part, merely a fragment.*[11]

Thus, open hierarchical systems are essentially rule-governed in their behavior and characterized by enormous flexibility and freedom of choice. These flexible strategies are guided by feedbacks. Living systems, also known as complex adaptive systems, strive to maintain homeostasis. Homeostasis is the maintenance of critical variables within normal limits so that an overall organism can continue to function effectively.

Semi-autonomous Sub-wholes

Take the living system most intimately familiar to all of us: the human body. We've long known that our bodies behave as a community of cells. It has a central nervous government that continually monitors all its parts and functions, ever making intelligent decisions that serve the interest of the whole enterprise, and an immune defense system to protect its integrity and health against unfamiliar intruders.

More recently, microbiology has revealed the relative autonomy of individual cells in exquisite detail: every cell constantly making its own decisions, for example, of what to filter in and out through its membrane, and which segments of DNA to retrieve and copy from its nuclear gene library for use in maintaining its cellular welfare.[12] Hardly the instinctual protoplasts we had originally thought them to be!

It is clear that the needs and interests of individual cells, their organ "communities," and the whole body must be continually negotiated to achieve systemic and dynamic equilibrium: balance. Cancer is an example of what happens when this balance is lost, with the proliferation of individual cells outweighing the needs of the whole. In the same sense a mature ecosystem, such as a rain forest, is a complex ongoing process of negotiations among species and between individual species and the self-regulating whole composed of the various micro and macro species along with air, water, rocks, sunshine, magnetic fields, and so on.

Obviously metaphors have their limits, and I do not for a moment suggest we completely emulate body models. But we

often paradoxically trumpet mechanical metaphors of perfect societies running like well-oiled machines. We all have these metaphors in common regardless of our worldviews or our political or spiritual persuasions, and they do exemplify the main features and principles of all healthy living systems or holons, be they single cells, bodies, families, communities, ecosystems, nations, or the whole world. By understanding them we can assess the health of any particular living system and see where it may be dysfunctional. This in turn will give us clues to making the organization or enterprise healthier.

Holonic performance then requires the ability to know what is actually happening, determine capabilities, and forecast the potentialities. There is no room for rigid, static targets driven from the top down. The ability to adapt to sudden and rapid change requires an inherent built-in intelligence so that one unit can communicate easily with other units. This type of performance must operate in an autonomous, distributed, and cooperative system.

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Holonic Performance Management

Holonic performance management systems (HPMS) are systems by which characteristics of open hierarchical systems are combined with Stafford Beer's viable system model from cybernetics[13] to produce appropriate feedback loops that will allow an organization to maintain homeostasis according to a balanced scorecard.[14] The use of the Shewart's control cycle[15] is used to promote overall circularity and set the scaffolding for logical feedback structures.

Central to the notion of high performance management is the understanding of the holon in the structure of complex adaptive systems as well as universal evolution.[16] Each performing unit is considered a holon, and must cooperate with other holons at its level, from planning and scheduling to physical production to the construction and delivering of knowledge. It challenges the command-and-control structure of business and organizations.

In a high-performance management system, rigid, static, and hierarchical organizations give way to structures that are more adaptable to change. The measuring systems must accommodate this change. The units will have to be designed so that they have inherent intelligence with the ability to communicate with other units in a "real time" fashion. Thus the subsystems will have to be autonomous, distributed, and cooperative.

By giving an organization autonomy at the appropriate holonic level, a structure can be transformed from any hierarchy

to a systemic structure that displays autonomy and cooperation in appropriate doses. By doing so, the sub-units will have:

- elimination of the need for central command and control
- self-configuring capabilities
- reconfiguring flexibilities
- capability to integrate human work to grand strategy
- reusability anywhere in the organization
- capability to realize individuals' role in the organizations success

It should be re-emphasized that holons are not clones. Each holon has an individual uniqueness even though it has evolved out of homologous patterns as other holons at its particular level.

The most important facet however, is that the desirable holonic behavior, especially that of individuals, is incorporated into the overall structure. Feedback loops must be developed to provide information by which the ratio of actual to capable performance can be determined. The entire range of activities that will be performed, including some of those that are under "sea level," must be surfaced and provided real-time performance ratios.

A primary task in designing a holonically structured organization is to develop the organizational mappings such that the human-machine interfaces are cooperative. On one hand, the individuals cooperate to achieve grand strategy goals; on the other hand, the organizational holons are distributed to obtain and use computing power, requisite geographical space, and communication networks. Applying the principles of complex adaptive, open, hierarchical systems will lead to new ideas of organizational control loops using technology that will be compatible with holonic or viable system organizational structures. Thus, an effective HPMS is composed of holons, each of which contains people, communications network, methods for feedback, and a physical processing system.

The primary feature of high-performance management is the installation of communication channels in both the vertical and horizontal direction.

The primary feature, then, of high-performance management is the installation of communication channels in both the vertical and horizontal direction. It is the horizontal-level communication that is the most troublesome to implement. The within-species communication model is an appropriate analogy to display horizontal communication. This is why humans must be given feedback from the technology they interact with to enable them to provide autonomous decisions within a pre-given decision range. Thus, an HPMS is an anthropocentric model and contains within it a revolution in the way we empower and control.

HPMS remedies the perception that humans and automation cannot be integrated. Compatibility will be merged in terms of competence, skills, and decision abilities related to the retrieval of knowledge. The feedback systems, people, and the physical processing system form a sub-unit holon.

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Making Our Organizations Work

The entire structure of society has a problem of adaptation. When we come to management of the organization, the same problem exists. What is needed now is a total reappraisal of our way of managing organizations. This entails a likewise complete reconsideration of the traditional (industrial) organization. The problem of organizational adaptation is a problem of organizational planning, and should not be looked at as being solved by conventional wisdom. How to run companies, how to organize them, and how to run government efficiently is just not clear anymore. Holonic performance management system development is an attempt to provide a living systems analogy to the science of organizational management. It incorporates cybernetic concepts with an understanding of the laws of large numbers. The viable systems model, being a holonic structure itself, provides a scaffolding from which the concepts of autonomy and cooperation can be mapped from holonic characteristics.

Aristotle coined the word "entelechy," meaning the realization of an inherent, embedded potentiality. Organizations should be striving to achieve potential. In order to achieve entelechy, we must be able to measure performance. The structural/conceptual model by which the methodology might best operate has been proposed to operate under open hierarchical principles—holarchical principles.

These principles provide an emerging structure to detect, recognize, measure, and adapt to changes in the internal and external environment of an organism/organization. These changes induce relative gaps in the unrealized potential of an organizations' achievements. Holonic systems are viable, and all viable systems are autopoetic. Organizations structured with holonic performance concepts supporting viable systems will be lasting and able to handle any exponential growth curve they encounter.

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