Bracing for the Future

Complexity and Computational Ability in the Knowledge Era

June 30, 2001 • Emergence
Arnold Wytenburg


Since the mid to late twentieth century, change has become the central issue in almost every aspect of business concern. That change arises from the exponential growth in information. This growth marks a trend that began in the early 1800s, gained momentum immediately following the Second World War, and came to dominate social, cultural, political, and economic agendas in earnest, beginning in the early 1960s. The complexity brought on by this increase in information density has now reached a stage where traditional approaches to designing, managing, and operating business organizations must be radically altered or, in many instances, completely redefined.

To prevail, corporations must act to transform their most basic notions of organizational thinking and behavior to accommodate the complex, volatile, unpredictable, and unfamiliar socioeconomic environment characterizing the unfolding knowledge era. As daunting as this may be, the task presents an even greater challenge than seen at first glance: a reliable model for corporate success under such circumstances does not yet exist.

Twice in the past millennium, humankind has undergone substantial socioeconomic change. The first instance marked the transformation of an agrarian society into an industrial society. Today’s age of information marks the cusp beyond which lies the second instance.

That future is defined in terms of an underlying matrix of informational relationships and interactions that simultaneously creates and is described by the nature and behavior of the encompassing socioeconomic context. The knowledge era that is unfolding before us arises from this increasingly tangled matrix.

FROM TOOLS TO CAPITAL

The agrarian era was characterized by humankind’s relentless focus on the goods of production. To understand the socioeconomic nature and behavior of our world at that time, one needed simply to “follow the goods.” Thus, an understanding of people’s ideals, behaviors, and intentions with respect to those goods provided an accurate proxy or map of the prevailing business landscape.

In the agrarian era, advantage went to those who could master the production of goods. Ultimately, we witnessed tremendous energy and focus directed toward creating and leveraging the technologies of production. The increasing cost of those technologies created the need for a new kind of mastery on a societal scale. Eventually, we came to witness a shift in focus, from mastering technology to leveraging financial capital as the dominant socioeconomic priority.

As technologies grew in sophistication, capacity, and importance, they also became more specialized, more fragile, more stationary, more costly, and ultimately less fungible. The need for increasing amounts of monetary wherewithal, subsequently followed by the need to amortize technology resources over periods of time that exceeded the scope of traditional agrarian cycles of production and exchange, led to a new socioeconomic orientation.

In short order, there appeared socioeconomic intention and activity following a rhythm that later echoed itself in a fundamental shift of attention toward mastery over financial capital rather than goods of production.

Ultimately, the relationship between landowner and labor no longer formed the basis on which the socioeconomic nature of our world was founded. In its place were industrialists wielding powerful technologies capable of transforming input resources into output goods and services with unprecedented efficiency, accompanied by capitalists providing the financial means necessary to develop, acquire, and apply those technologies seemingly without limit. Thus was born the industrial era.

Capital-driven industrialization coupled with the effects of population growth as well as sociocultural and sociopolitical expansionism placed increasing demand on the relationships among each and every constituent of the industrial era, yet no relationship played as significant a role as that between industrialist and capitalist. Access to and acuity with financial resources rapidly became the most critical factors of business success.

THE ROLE OF THE CORPORATION

With the dawn of this new era, the idea of the modern corporation was born, primarily to facilitate the relationship between
With every change in the market environment, more and new information is created and accumulated, each new instance lies the essence of so many of the difficulties that today's corporations face: They are adrift in a vast ocean of information, from available information continues to grow by the nanosecond, meaningful knowledge is equally rapidly becoming scarcer. Therein, technology that has supposedly rendered them more "informed" than at any other time on record. Curiously, however, while technology that has supposedly rendered them more "informed" than at any other time on record. Curiously, however, while managing information is met with the demand for even more of it. Yet paradoxically, each advance in corporations' capacity for technologies necessary to make information manageable. Further fueled the growing demand for information from all directions. Inevitably, corporations found themselves at the center of this demand, being forced to spend more and more of their scarce, costly capital resources in the creation of information as well as its processing, communication, and husbandry.

And so, within the very essence of the change that brought about the industrial era, there was also written the signature trace of what would ultimately bring about its eclipse and, in so doing, signal the beginning of a transition to the knowledge era.

**FROM CAPITAL TO INFORMATION**

On entering the knowledge era, we see another shift occurring, this time calling for an overall emphasis on the mastery of information, described here as computational ability. As the new millennium begins, the primary content of practically every socioeconomic interaction has become substantially made up of—or, at the very least, dependent on—information. Even traditional, tangible products as simple as bricks and mortar possess increasingly greater and more significant information content: Information has literally become the stuff of corporate life.

Practically every transaction undertaken by people in today's society is reflected in the tacit and explicit "signature trace" of information that is created, consumed, modified, maintained, embodied, and eclipsed by that transaction and the parties to its execution. Increasingly, it is necessary to consider information in abstraction rather than by seeking to understand merely its content.

In the agrarian era, the movement of direct goods and services provided a proxy for understanding socioeconomic intent and behavior. In the industrial era, the movement of financial capital replaced this proxy. In the knowledge era, the ebb and flow of information will fill this role. By seeing information as a system that simultaneously embodies both "content" and "context," it becomes possible to develop a meaningful and useful understanding of the orientation, organization, and behavior of the environment of that information.

In essence, it is possible for these signature traces to reveal the dynamics of socioeconomic focus and endeavor and to thereby serve as a substantially accurate proxy for the extent, nature, form, and behavior of the postindustrial marketspace of the knowledge era.

**CHANGE AND COMPUTATIONAL ABILITY**

The ability to produce information is growing faster than the ability to employ it. During the later part of the twentieth century, widespread, low-cost transportation and communication compressed business cycles, redefined sociocultural and geopolitical boundaries, and thus altered and increased the intensity of competitive interaction.

As part of this, corporations produced and accumulated more information than their preindustrial predecessors could even begin to have imagined possible. In turn, that growth spawned truly monumental advances in the development of the disciplines and technologies necessary to make information manageable. Yet paradoxically, each advance in corporations' capacity for managing information is met with the demand for even more of it.

Since the mid-1950s, corporations have been engaged in a dramatically escalating relationship between information and technology that has supposedly rendered them more "informed" than at any other time on record. Curiously, however, while available information continues to grow by the nanosecond, meaningful knowledge is equally rapidly becoming scarcer. Therein lies the essence of so many of the difficulties that today's corporations face: They are adrift in a vast ocean of information, from which they are increasingly less able to obtain any usefulness.

**WATER, WATER EVERYWHERE...**

With every change in the market environment, more and new information is created and accumulated, each new instance
bringing with it more change. Repeating itself seemingly endlessly, this pattern acts to build on each prior instance of change, layer on layer, thereby increasing the information density of the world in which we exist. Ultimately, more and new degrees of complexity appear. In spite of the time, energy, and resources committed to keeping pace, most corporations are quickly reaching the limitations of their sense- and meaning-making competencies.

Since the commercialization of the digital computer, trillions of dollars have been invested in the development of corporations’ capacity for processing information. And yet, even the most heavily invested can do little more than tread water, while thousands more drown in a sea of information. Why, in spite of their unprecedented investments of focus and attention, do the majority of today’s corporations remain at the mercy of information?

Substantially, the issue lies in the distinction between computational ability and processing capacity. While complicated, expensive, and time consuming, information processing is essentially little more than a mechanical, quantitatively-oriented process requiring limited human intervention given today’s advanced technologies. Computational ability, on the other hand, involves human acts of knowing and understanding.

**THE COMPLEXITY CHALLENGE**

With the phenomenal rise in the information curve comes a quantum increment in the degree of complexity existing within the market environment. This, in turn, has the effect of substantially increasing the need for computational ability. The challenge facing corporations in the knowledge era is not a processing challenge. Instead, it is a matter of their ability to obtain, develop, and leverage knowledge.

This shift in imperatives accompanying the emergence of the knowledge era forces a new approach to corporate orientation, structure, and performance that differs radically from tradition. Increased complexity within today’s business environment calls on corporations to recognize and respect a new and different reality than the one to which they have become accustomed.

Coping with a quantum shift in complexity was never considered a criterion on which historical methods of organizational design, management, and operations were based. Simply implementing additional information-processing technologies or imposing greater administrative control merely serve to increase frustration.

As the pace of change in the business world continues to accelerate, assumptions about our points of reference are being challenged. This is experienced at first hand through the failure of all but the most shortsighted of corporations’ predictive devices. While change in the market environment may indeed be the basis on which corporations must act, it is not the cause of their problems: the real culprit is complexity. This complexity arises against a backdrop of unrelenting change.

Many of today’s corporations simply weren’t designed for the confusion and uncertainty characterizing current socioeconomic conditions, let alone for what the knowledge era promises. The principles, priorities, and imperatives making up the historical context within which most existing corporations were founded simply don’t reflect the realities of today’s business world.

**RETHINKING KNOWLEDGE**

At the onset of the industrial era, corporations were legitimately conceived as cause-and-effect machines, designed to leverage the deterministic nature of an essentially stable market environment to the express advantage of those at the helm. Such approaches lack the critical ability to function in an environment that is ambiguous and uncertain.

If it were simply a matter of processing larger quantities of information, technological advances alone would save the day. The problem is specifically not one of dealing with the volume of information, but rather one of the radical increase in complexity brought about by its proliferation.

Knowledge is a matter of understanding the relevant and discrete facts, data, and information, as well as the nature and impact of the conditions and relationships that bind them together. The greater the degree of complexity in an environment, the more various, dynamic, and unpredictable are those situations. When that environment is also volatile and uncertain, the value of a given instance of knowledge generally has a tightly limited scope of accuracy and relevance as well as an extremely short shelf life. The highly volatile, unfamiliar, and uncertain nature of today’s socioeconomic environment is such that much of the knowledge critical to corporations’ viability and success is best described as “truth within the moment.”

The changes that both reflect and bring about the prevailing socioeconomic complexity of our world are neither familiar nor predictable. Under such circumstances, meaningful and readily achieved understanding is all but impossible beyond the immediate timeframe. Computational ability—essentially the capacity for sense and meaning making within the moment of need—becomes the critical factor of survival under these conditions.
Research and experience show that the more complex an environment, the more dense, diverse, and vibrant is its positive and negative potential. Translated into business terms, this suggests that the more readily corporations can understand and embrace the complexity of their environment, the healthier and more productive they are likely to become and remain.

In a fast-paced world where little is stable or predictable, knowledge begets other factors of production far more readily than they can beget knowledge. Thus corporate mastery of information, rather than financial capital, is rapidly becoming the most critical factor of business success. What was taken for granted only a few short decades ago—knowledge, and the means of its acquisition, development, and leverage—is becoming the single most sought after and most important production factor in practically every quarter of socioeconomic concern.

KNOWLEDGE IN A POSTINDUSTRIAL ERA

Knowledge is an act of orienting information within a framework of perception, comprehension, and application. The more dynamic the environment, the more difficult is that act. The more complex the environment, the more narrowly the result can be applied meaningfully.

In a business environment characterized by complexity, volatility, and unpredictability, what is produced by the act of knowledge rapidly becomes inconsistent, unreliable, and even contradictory. Corporations unable to continuously reinvent their perceptions and conclusions in the face of an ever-changing and never-certain context quickly find themselves unable to sustain a competitive profile. Inevitably, that misalignment will lead to fragmentation, then isolation, and, ultimately, to corporate failure.

The misalignment that arises as a consequence of outdated, insufficient, incomplete, or inaccurate understanding of the environment breeds anxiety and discomfort among a corporation’s leaders and workers alike. This, in turn, often elicits exactly the type of organizational response most likely to result in corporate failure: attempting to force new information into familiar, traditional frames of reference. Such approaches generally focus on extending and reinforcing what is already known, rather than on attempting to discover what is not known.

The alternative is to embrace change as a natural aspect of our business world and to seek to continuously create a ready supply of fresh awareness, perspective, and insight on which to base corporate orientation, structure, and behavior. Embracing misalignment as a systemic reality insists that corporations replace their emphasis on possessing complete, definitive control with a capacity for creating an understanding best described as a continuously evolving “truth within the moment.” In short, corporations must revise their perspectives on knowledge, from prioritizing it as a periodic, ancillary activity to one that is intrinsic within every action that is undertaken.

DESIGNING FOR KNOWLEDGE

Knowledge can only occur within the context from which it emerges. It is substantially dependent on tacit perceptions, or mental models, of reality, and is both qualitatively and quantitatively defined by the sophistication and self-referential nature of those models and their related processes and practices. Typically, when corporations encounter information that cannot be readily assimilated within their existing models, most fail to perceive the information at all.

For instance, when a change in the market environment involves a quantitative shift, the information signaling this change generally takes the form of an imperative to adjust volumes of production—this is precisely the attitude toward change that guides the way most of today’s corporations are designed, managed, and operated. Such a change fits within the boundaries of a pre-established range of understanding that the corporation already possesses for recognizing and coping with change.

However, not all change is as described above. Increasingly, corporations face situations where the nature of the change they encounter is substantially unfamiliar and unexpected. In instances where market conditions are being fundamentally or rapidly altered, corporations generally have no pre-existing means of recognizing and responding effectively to such change until too late, if at all.

Too often, corporations are unaware of changes in their markets until disequilibrium has become deeply entrenched. This so-called “crisis of perception” places a corporation’s essential orientation and behavior out of alignment with its context, thus putting the enterprise in jeopardy of losing its competitive position to a more knowledgeable contender. To avoid being overwhelmed in this way, corporations must approach knowledge from the perspective of enhancing their ability to perceive and act on new and unfamiliar information more quickly, effectively, and efficiently than their competitors.

As information assumes an increasingly larger proportion of the content of corporations’ productive activity and output, the importance of possessing as well as being capable of immediately acting on the most relevant and up-to-date knowledge becomes the defining critical success factor. In the complex world foreshadowing the knowledge era, computational ability becomes corporations’ top strategic priority.

In short, corporations must focus their strategies on the processes of continuous sense and meaning making needed to ensure that their priorities, infrastructures, resource allocations, and production efforts remain aligned within the context of a
socioeconomic environment in constant flux. The priority for knowledge-era corporations is thus continuously to expand the nature and extent of their knowledge, rather than merely increasing the certainty and understanding of what is familiar.

KNOWLEDGE AND THE POSTMODERN CORPORATION

Knowledge is not a passive, discrete, or ancillary activity or event. It is substantially heuristic and does not occur separate from the context within which it derives its relevance. Thus, in effect, every action a knowledge-era corporation takes by definition must incorporate within it the ways and means of establishing and capitalizing on itself.

Ultimately, to realize knowledge mastery in this way requires individuals and small groups of people acting locally, subjectively, immediately, and flexibly within the moment of need in ways that concurrently contribute to the integrity and alignment of the overall enterprise.

Almost every approach to organizational design, management, and operation now in use leads to corporations, organizational units, and employed individuals that are substantially and rigidly isolated from each other. Practically speaking, this makes timely, effective, and interactive systemic alignment all but impossible. A fundamentally different orientation is required.

When a socioeconomic environment's defining parameters undergo such change as we are now experiencing, the imperatives prevailing on corporations are restated. In the industrial era, the ability to limit demand on financial capital was the corporation's critical success factor. In the knowledge era, however, the ability continuously and concurrently to create and leverage new knowledge will become the corporation's most important measure of performance.

To align with this, knowledge-era corporations must appear not as concrete, well-defined, structurally consistent entities, but instead as mutually engaged, individually accountable, and dynamically variable networks of participants in a complex and continuously changing infinity of "systems of systems within systems."

FROM MECHANISM TO RELATIVISM

Industrial-era thinking presumed that all things could and should be understood in an objective, reducible, and mechanistic way. Traditional approaches to defining corporate boundaries are a function of this deterministic "whole is the sum of the parts" perspective. This approach, however, substantially fails to come to terms with the dynamic, complex, and unpredictable nature of the contemporary business world, where not only is there far more at play than we can possibly know and understand, but also where the parts' behavior is increasingly unpredictable and even strange.

To sustain themselves successfully under such prevailing conditions, corporations must act constantly and diligently to update their understanding of the context within which they participate. This requires a formal acceptance that the "system" in which they are engaged is ultimately unknowable and uncontrollable in any traditional sense. This implies that corporations must adopt the ways and means of constantly testing, adjusting, and refreshing their network of informational relationships and alignments in unpredictable and unprecedented ways.

COMPUTATIONAL ABILITY AND THE NEW SCIENCES

In the mid-twentieth century, the abstract principles of the so-called new sciences found practical application through the emerging disciplines of nonlinear system dynamics. What these disciplines did to aid our understanding of the complex nature of the universe, they could also do for improving our understanding of the ways and means of everyday life.

Based on this notion, systems theorists succeeded in fundamentally reshaping our views on the nature of the sociotechnical environment.

During the 1960s and 1970s, these disciplines crossed a boundary into the so-called soft sciences of sociocultural, sociopolitical, and socioeconomic concern. The late 1980s and early 1990s saw the arrival of an organizational discipline simply called "systems thinking." In parallel with these developments, interdisciplinary work among leading thinkers brought forth a comprehensive theory of chaos and, with it, workable theories of complexity and emergence. From these efforts evolved a worldview describing social, cultural, political, and economic systems not only as complex, dynamic, and unpredictable, but also as possessing a self-organizing adaptive capacity.

In the new language of systems, it is the synchronized interaction of the parts that optimizes the performance of the whole; while, concurrently, it is the optimum state of the whole that facilitates the synchronization of the parts. The complexity viewpoint suggests that the boundary conditions of a system are substantially a result of the perspective that one chooses to take within the moment of the need to do so. Under the emergence hypothesis, the inherent strength and viability of a system lie within its innate capacity to exist in a state of continuous flux, moving synchronously with the ebb and flow of the information landscape in which it exists.
Needless to say, these assertions find themselves wholly at odds with the conventional wisdom of mechanistic determinism, which posits that optimizing the whole is simply a linear function of optimizing the parts.

While these philosophies, proofs, and disciplines may seem somewhat abstract to the corporate ear, they have tremendous implications for understanding and explaining how corporations must behave, interact, and organize in the knowledge era. Based on these new perspectives, the principles and assumptions historically held to be true with respect to designing, managing, and operating corporations are no longer up to the task, demanding that they be rethought, redrafted, and rebuilt from the foundation upward.

Using the “new science lens,” the knowledge era corporation is conceived as an unending progression, or thematic unfolding, along a continuum of activity that seeks continuously to adapt to the tension existing between chaos and order, all for no purpose more singular than to ensure ongoing sustainability of itself and its constituents as well as its overall environment. The challenge for such corporations is to develop the ability continuously to sense, learn from, and adjust to their environments without missing a beat. In short, this calls on corporations to be capable of existing in a state of constant change.

Business success in the knowledge era calls for a fundamental shift in a corporation’s perception of its role and purpose: Such corporations must become avatars of a future that they actively, consciously, and continually create. For these corporations, survival and success are not about doing change successfully. Rather, they are about being change successfully. Few corporations existing today have developed this capacity.

CONCLUSION

As modern humanity enters the third millennium, the industrial era is seen as rapidly giving way to the knowledge era. In this future, only those corporations that are fully, consciously, and continuously aware of and aligned with the complex and ever-changing nature of their socioeconomic context will gain and hold competitive advantage. Increasingly, this requires that corporations become adept at existing within a state of “constant white water.” Under such conditions, computational ability, not information-processing capacity as is too often assumed, becomes corporations’ highest performance imperative.

References


