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What is a Game-Changing Design?

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***Abstract* – Innovation is crucial for success in the current business environment. Boeing is one of the most innovative companies in the world but there is more we need to do to drive innovative thinking deep into our culture and replicate it across the Boeing Enterprise. Recent research has demonstrated that the principles and practices of Design Thinking drive innovation. As a demonstration of the importance of this new paradigm, business schools are adding Design studies to their curricula, new graduate schools that focus solely on Design as a discipline are being stood up, and both business and scholarly literature are providing case studies of how Design Thinking is transforming corporate cultures and enhancing competitive advantage. This article provides a survey of the key elements of the Design Thinking mindset and suggests specific interventions that Boeing can look to adopt to continually enhance our ability to excel in invention and innovation in all areas of our business.**

***Index Terms* – Innovation, design thinking, whole systems design, workplace culture, organizational design, competitive advantage, analytics, knowledge creation, institutionalize systems thinking, continuous learning, mentoring, partnering.**

I. Introduction - What Is a Game-Changing Design?

In the beginning, was the link. This simple and yet profound disruptive technology of the Internet moved us into the world of virtual relationships and forever changed the accepted organizational form. The Web transformed traditional business boundaries from impenetrable firewalls to semi-permeable membranes that struggle to control an inherently uncontrollable phenomenon—human-to-human interchange. The Internet was clearly a "game-changing design" that employed new technology breakthroughs that transformed traditional business practices.

Increasingly, however, "breakthrough innovation in products and services seems increasingly difficult to achieve" [2]. There are strong indications that the next horizon of game-changing designs will represent radical shifts in how people think about and perform their work. The economic survival game of keeping ahead of competitors has become much more knowledge driven [1]. Davenport and Harris argued, "At a time when companies in many industries offer similar products and use comparable technology, high-performance business processes are among the last remaining points of differentiation" [2]. What employees know and discovering ways to enable them to work together to grow that knowledge into competitive advantage is the next frontier.

What has been referred to as "discontinuous context changes" [3] increasingly challenges businesses to ask: What actually are the viable differentiators in today's global business environment? What enables a company to continually reinvent itself? What are examples of "game-changing" strategies that will disrupt business-as-usual enough to shift outmoded paradigms?

A lesson from the world of education might apply here. In doctoral research, there are two paths to knowledge: quantitative research and qualitative research. Perhaps we could apply that model to the world of business and combine the institutionalization of a design culture (a qualitative value) with competitive analytics that serve fact-based decision making (a quantitative value). A balance of these two paradigms, supported by a robust learning infrastructure and a deep understanding of systems and their dynamics, might prove to be a strategy disruptive enough to our established organizational forms to allow us to escape the groove we find ourselves in and strike out in new directions.

The following disruptive strategies are offered as "game-changing" interventions that Boeing can adopt to begin to cope with our 21st century knowledge-creation challenges: (1) synergize the corporate culture with design principles and practices; (2) adopt and proliferate a deep understanding of systems and institutionalize systems thinking; (3) catalyze radical change readiness through peer-to-peer apprentice-

style mentoring and partnering; and (4) maximize understanding, visualization, and strategic use of competitive analytics.

This package of complex, interdependent strategies is not an easy undertaking. Even as we attempt to change the game, the game itself is altered. To change the game, the underlying structures must be fundamentally changed. What holds today's corporate and civil institutions in place are the "patterns that connect" [4] one person with another, one culture with another, and one idea with another. To change the game, we have to look through to the skeleton of values that supports the corpus, study the interconnections, and look to the revealed trends and patterns to understand what holds the whole structure in place. When we see this deeply into a phenomenon, we can begin to influence it, but this requires a powerful will and a sustaining vision. A desire for increased market share won't support this kind of long-term strategic direction shifting. If we are looking to change the game, leadership must design a vision that will address the whole system and the "hidden connections between phenomena" [5]. Our business leaders already hold up continuous learning as a foundational corporate strategy that assists us in the on-going shift from bounded organizational views to a whole systems paradigm. To be knowledge-driven may mean that having to know more is a business imperative but knowledge alone won't fast-track us at the speed we need to travel. A knowledge incubator is needed—an organizational and contextual hot house for growing that rarest of flowers—sustainable success. This multidimensional change mandate can begin with the institutionalization of a culture of design.

II. Institutionalization of a Design Culture

Knowledge is "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" [6]. The last two decades of the 20th century could be characterized as an era of "fast knowledge"–that is, knowledge that is driven by rapid technological change and the rise of the global economy [7]. With the advent of the 21st century has come a new awareness that fast knowledge often outstrips our ability to imagine the outcomes of its application. The 2008 global economic crisis vividly demonstrates this phenomenon. The difficulty in resisting fast knowledge is that it delivers short-term benefits and defers the cost to the future. September 11, 2001 shocked the United States into accepting its vulnerability to global forces. September, 2008 awoke us to our vulnerability to global financial forces and showed us that international finance in an interconnected world is a new game that we must learn how to play. A takeaway from the lessons of this first decade of the 21st century could be that the velocity of knowledge can be inversely related to the acquisition of wisdom [7]. Situating knowledge in a holistic context fundamentally shifts our worldview to reveal what was previously invisible or unnoticed–the margins, the context, and the context's hidden interconnections.

The transformation that can come from this wider vision moves us from a less mature, individualistic, and isolationist cultural model to a more mature, relationship-based, holistic model. The philosophy and discipline that best exemplifies this mental model is Design.

The idea of design thinking may be the single most important business concept to emerge from the 20th century. Design thinking is a perfect complement to the earlier efficiency movement. While the scientific method of management espoused by Frederick Taylor and later refined by Juran and Drucker provided a key framework for how work should be done, design thinking answers what, as well as why, a given thing should be done [8].

In the late 20th century, with the advent of vast systems of communication, design as a "science of the artificial" [9] or human-made world came into being. Nelson and Stolterman captured the essence of this phenomenon with their definition of design as "the ability to imagine that-which-does-not-yet-exist, to make it appear in concrete form as a new, purposeful addition to the real world" [10]. Warfield described design as "the visible manifestation of what we know about the sciences and humanities, when applied to alter[ing] the natural universe . . . it is a process of creating alternatives to augment those provided by nature" [11].

Much has been written about the discipline of design. The insights of Bruce Archer, Nigel Cross, Bela Banathy, and others who brought forward the "Discipline of Design" and placed it beside the traditional disciplines of the Humanities and the Sciences, introduced a new thought paradigm that reflected the naturalness of operating synergistically together [12] [13] [14]. Design thinking, or seeing everything in relationships [15], fit the explosion of need for relationship-based knowledge and its partnering technologies that emerged in the late 20th century.

Herbert Simon boldly wrote "the proper study of mankind is the science of design, not only as the professional component of a technical education but as a core discipline for every liberally educated man" [9]. Margolin and Buchanan described four broad areas of design as (1) design of symbolic and visual communications, (2) design of material objects, (3) design of activities and organized services, and (4) design of complex systems or environments for living, working, playing, and learning [16]. When the "design of action" [17] is added to Margolin and Buchanan's list [16], human intention is placed center stage, highlighting the essential nature of design thinking.

Design is "essentially a synthesizing process. Its product is always a system, a set of interrelated parts that form a whole" [18]. The principles that constitute designerly ways of knowing [13] are foundational to reflective, integrative, and compositional ways of thinking that are being nurtured in university settings like the new d.school at Stanford University "where people from large companies and startups

alike come to learn design thinking" [19]. The ability to manifest an idea that fulfills a critical need is the alchemy that is sought in the concept of a knowledge-driven corporation. Knowledge making can be seen as design action, as "design is a synthesis of creativity [or invention] (imagining new things) and innovation (bringing those new things into existence)" [17], or making a significant improvement to an existing product, process, or service. Design is disciplined inquiry. What works in opposition is the culture and complexity of contemporary corporate organizations that are often dis-incentivizing to those working to make the shift from the era of the expert individual to an integrated and collaborative team working together through a knowledge-creation paradigm. The context or holding environment where knowledge synthesis is intentionally nurtured to maturity is referred to as a "design culture."

A design culture is an integrated pattern of human behavior that is manifested in (1) design's own distinct ways of thinking; (2) the use of modeling, which is the language of design; (3) design concepts and principles that constitute the theory of design; and (4) the means and methods of design, by which creativity is applied in actions of inventing, making, assessing, and doing [13]. Business now is beginning to see the discipline of design and the institutionalization of a culture of design as fundamental building blocks for the transformation of knowledge into wisdom.

The idea of a culture of design that could be instantiated within an organizational context to foster design reasoning, judgment, and practice emerged along with the discussions of the learning organization. Schön first articulated the idea of adaptive and learning-capable social systems [20], which became the foundation of his later work with Argyris on organizational learning systems [21]. Schön articulated the requirement for businesses to provide a work environment that would offer the "extraordinary conditions that included placing a high priority on flexible procedures, differentiated responses, qualitative appreciation of complex processes, and decentralized responsibility for judgment and action . . . making a place for attention to conflicting values and purposes" [22]. Schön was one of the first to bring together the interdependencies and interconnections between innovation and learning, a systems paradigm, and a focus on design action experienced in the business world through organizational forms such as the "design studio" [23] [24]. Others built on the synthesis of these ideas to conceptualize a culture of design in a workplace context as both an incubator for creative thought and a catalyst of design action.

Here, I would draw a clear connection to a previous article in this Technical Journal from July 2012 that discussed "Challenges to Innovation in Information Technology Core Infrastructure." In that article, Craig Dupler called for "innovation managers" and argued that "without a meaningful process that catalyzes teaming and helps the organization benefit from each other's strengths . . . innovators tend to produce isolated and semi-redundant non-integrated systems." Prominent leadership of the innovation agenda is essential to adjusting management's priorities to focus on supporting processes and structures.

A key structure of a design culture is the collaborative design team. Design teams demonstrate the art of making things that fit harmoniously in their ecological context [7]. A design team is a purposeful social system, a "multi-minded system" [25], that has the ability to create alignment among members within the context of design action. Participation in this alignment has been characterized as "flow" that is, an experiential state of cognition without the normal distinctions and distractions of measured time and space [26]. Design is an intentionally directed process that motivates individuals to collaborative action and helps to eliminate elements of human interaction that drain energy and human potential. A focus on deep and continuous learning ignites this potential within the conductive containing environment of a design culture.

The pace and intensity of creating and sustaining design culture requires integrated design teams and other collaborative forms of team structure that are themselves designed. Members of a design team must be carefully chosen for the qualities they bring and should be assessed against criteria such as their characteristics in the following nine areas [27].

Cultural competence: Cultural competence is the knowledge, skills, and attitudes that are required to engage in and carry out mutually satisfying cross-cultural, cross-gender, or other encounter or dialogue across differences. Collaboration skills allow team members to participate, learn with others, and share in both word and graphic language thoughts and ideas that are essential to design action.

Judgment: Judgment is the ability to apply wisdom, set, and solve ill-defined problems that have multiple sets of interdependent variables (complexity), and learn from consequences, as opposed to an ability to make decisions and solve well-defined problems.

Empathy: Empathy allows us to project ourselves forward into the experiences of others in order to gain insight and enable the interpretation of intangible meaning in what others say and do.

Creativity and innovation: Design is inclusive of creative thinking and includes innovative activity, which applies creative concepts to real-world situations.

Tolerance for ambiguity: Tolerance for ambiguity is an embrace of uncertainty and acceptance of complexity.

Positive attitude toward error: Seeing error and failure as sources of learning encourages risk-taking and exploration of possibilities.

Bias toward service and responsibility: Bias toward service and responsibility is a view of organizational life as an act of ethical composition on behalf of oneself and others.

Contextual awareness: Contextual awareness is a partner with cultural competence. Without deep awareness of the context in which one is operating, design collaboration cannot occur.

Systems thinking: Systems thinking is a holistic approach to understanding complex relationships and their feedback behavior, and it is characterized by intentional reflection in, and on, action [22]. It represents the habit of mind that looks for the often hidden patterns of interconnections and interactions that operate among the people, processes, structures, functions, information, and technologies within a particular contextual space.

This last competency of systems thinking is the critical element that creates the expansive mental models that enable the other design competencies to thrive. Senge selected out this Fifth Discipline to focus our attention on a profound shift in thinking that marked the 20th century [28]. The competency of systems thinking is foundational to the discipline of whole systems design.

III. Whole Systems Design and Systems Thinking

According to Gharajedaghi, systems thinking has gone through three distinct generations: (1) operations research, which explored the interdependency of context of mechanical systems; (2) cybernetics and open systems, which explored the dual challenges of interdependency and self-organization in the context of living systems; and (3) design, which responds to the triple challenge of interdependency, self-organization, and choice in the context of socio-cultural systems [25]. This last generation, where we find ourselves today, points to design thinking as a methodology for "creating order through clarity" [29]; a game-changing strategy that enables people to navigate to what is important in a world of infinite choices [29]. For today's knowledge workers, the question of what to pay attention to (the signal) and what to ignore (the noise) [30] is a daily challenge. The discipline that enables the production of "the right kind of order" [29] that enables learning to see the patterns that connect to form the whole, is whole systems design.

The biochemist Lawrence Henderson first used the term "system" to denote both living organisms and social systems [31]. From that time on, a system has come to mean an integrated whole whose essential properties arise from the relationship among its parts, and systems thinking as the understanding of a phenomenon within the context of a larger whole. To understand things systemically literally means to put them into a context, to establish the nature of their interrelationships, and to see through the complexity to the essential elements.

Whole systems design is the expression of the composition of design and the systems sciences. It is the intentional creation of wholes; the antithesis of the fragmented, siloed thinking that is at the heart of so many of our modern day business and social problems. Whole systems design is a process of intentional leadership. The outcome is the shaping and influencing of a composition that has never existed before. It is an emergent process that is always collaborative, most effectively performed within a diverse design team, and whose properties arise from the interrelationships of the essential elements. A whole systems designer's focus is on the creation of resilient systems that express the art of making things that fit harmoniously in their context. The pragmatic research on face-to-face leadership in teams and networks by Graen and his associates is a good example of whole systems design [32].

Systems thinking is the methodology for how designers think; it provides the skeletal design logic for dealing with complexity, a seminal attribute of organizations. Complexity leadership theory views organizations as "complex adaptive systems" [33] that require dynamic engagement by leaders in three oppositional tensions: (1) divergence/convergence; (2) autonomy/integration; and (3) potency/constraint in order to effectively address layers of complexity [34]. Systems thinking provides an inclusive and expansive paradigm that coheres such dualities and mines multiple domains of knowledge to frame problem situations as opposed to solving discrete problems. Systems thinking recognizes that problems never exist in isolation–that a particular problem is inevitably linked to other problems, which are in turn held in place and sustained by an identifiable structure or patterns of interaction. Systems thinking focuses on these patterns of interaction that are operating within a particular contextual space in order to first situate and then address the network of influences that participate in any situational challenge. Ackoff refers to this process as "problem setting," which is conceptually and operationally distinct from "problem solving" [35]. Designers employ design judgment to frame a problem space and judgment relies on knowledge. "Knowledge can be likened to a living system, growing and changing as it interacts with the environment" [6]. Thus, fostering a culture of continuous knowledge creation requires a systems paradigm.

In 1996, on the 100th anniversary of the New York Stock Exchange, it was noted that of all the original companies that had started up the Exchange, only General Electric had survived. This speaks to the fragile nature of business sustainability and to the imperative for a company to know "why" they are in business (a design question). GE answered it and survived while other businesses faded. American industry bowed its head to Japan in the mid-20th century and continues in a humble posture as the 21st century delivers the body blows of the 2008 global economic crisis. But the game keeps changing and game-changing strategies have to be aware of, and work with, this natural systems oscillation. We have to keep in mind that humans don't learn much from success. When we are successful, we tend to keep doing what we have been successful doing. Yet, experientially, we know that the deepest learning emerges from failure because the shock of failure triggers us to shift our thinking, which

leads to different behavior, which tends to reverse the failure spiral. This paradox of succeeding through failure is hard to recognize when you are on top, a caution we should all consider as we engage in the design of Boeing's future.

What systems thinking brings is awareness of the emergent properties of systems that cues us to the probability that when one problem is solved, another problem is created. Systems thinkers learn to look for these unexpected outcomes of their actions that often reveal what was perhaps hidden or masked before. They recognize that a success formula is only good once. Once it is executed, the game is changed forever, and a new strategy must be developed, based on the new rules. If the 2008 global economic crisis taught us anything, it vividly demonstrated the hidden interconnections among systems and the emergent systems properties that can take us by surprise if we aren't expecting them. Can there be any doubt now that different ways of thinking and decision making are required for this different world?

Increasingly, awareness of the vital role design and its thought paradigm, systems thinking, should be playing in both public and private enterprise is being shared across the globe. Lojacono & Zaccai argued a "design-focused enterprise …that exhibits the art and science of putting all the pieces together–technical, financial, operational, and emotional has much better business performance (based on profit margins) than firms that do not focus on design [36]. Market-leading companies report seeing design-consciousness as a competitive advantage, equivalent to a capacity for innovation and creativity [37] [38]. Companies that intentionally focus their knowledge workers on design thinking, which uses abductive reasoning (the logic of possibilities) in combination with inductive and deductive reasoning [39] have achieved substantive gains in innovation and enjoyed success in the dynamic global marketplace [8]. Furthermore, companies that view "managing as designing" [40] intentionally work toward a cultural paradigm that nurtures the creative spirit.

A focus on the cultural element inherent in all human activity systems allows design-conscious leaders to set a design agenda that is sustained through a design culture and continuously renewed through a systems approach to knowledge creation. The way these cultural elements become institutionalized is through a relentless focus on learning. The intentional design of a context for continuous learning in the form of a design culture puts in place the processes and structures to support sustainable knowledge acquisition paced and packaged for maximum absorption.

IV. Continuous Learning Through Peer-to-Peer Mentoring and Partnering

From the perspective of the systems sciences, mentoring and partnering are human activity systems that represent a "set of human activities related to each other so they can be viewed as a whole, consisting of purpose, process, interaction, integration, and emergence" [41]. The components of the system are part of a dynamic process, mutually influence one another, and cause the emergent properties of learning to manifest. In this way, mentoring and partnering can be seen as "seeding processes" [42] where individuals within a design team hone their relational skills; develop their ability to communicate across cultural, gender, and age boundaries; receive the gift of mirrored reflection; and invest in the learning infrastructure at a micro level in a way that will inevitably yield macro level benefits. For both mentoring and partnering, learning is varied under different cultural conditions and has a dependent relationship with the individual(s) engaged in the learning experience and their interactions with one another. Mentoring and partnering relationships have a high potential for learning outcomes because of their archetypal character, the diversity of learning styles they can accommodate, and the fundamental premise that the relationship is designed by the participants to support the learning; the interactions are configurable to some extent in order to enable the agreed upon learning goals.

When the acquisition of knowledge is "viewed as an active process in which curiosity is encouraged, learning becomes a dynamic, reciprocal, and participatory process" [43] that can be effectively sustained through mentoring practices. Mentoring and partnering are fundamental to what it means to be human. Without needing an explicit definition, we have a visceral understanding of this human behavior. However, this a priori assumption can be problematic as it sets expectations that may not be possible to fulfill given cultural constraints. Nevertheless, there is an unspoken knowing that mentoring and partnering behavior are demonstrations of some of the highest human values. These learning methods have proven themselves throughout history. The diversity of learning styles that can be accommodated is demonstrated, in part, by the diversity of mentoring and partnering structures that are being practiced in the modern workplace. The fundamental premise that mentoring and partnering relationships can be designed to accommodate the personalities of the participants, the unique context, and the particularity of learning purpose is what may have allowed them to outlive all other forms of knowledge transfer. These learning formulas are, to some extent, timeless in form and function [44].

Within the context of a design culture, peer-to-peer mentoring and partnering serve as both stabilizing and catalyzing elements. If we look at the rapid pace of technological innovation over the last two decades that moved us from the Internet to the Web and to what we now refer to as the Social Web, which will quickly morph to the Data Web and then to what is being termed the Knowledge Web, we can see an escalating pattern of behavior toward more and more meaningful interactions. We are clearly spiraling forward into the future while circling back to a time where culture was a more intimate experience born of

human-to-human interchange. Perhaps we are expressing that yearning to some extent through technologies like the Web that connect us across time and space and increasingly attempt to emulate what we experience when we have meaningful dialog and deep face-to-face learning opportunities. If we put aside the strident voice of Generations X and Y about career opportunities, their voices speak of a desire for a sense of purpose for their work; their message is that the modern corporate environment falls short.

When mentoring and partnering are focused on sharing the latest technological challenges and experimenting together within the safe space of a design team, attractors that are required to hold young people within the corporate culture are collaboratively created. One game-changing strategy for the application of design thinking and shared learning is competitive analytics, an emergent field that requires a unique combination of decades of experience and the latest knowledge in massive data analysis and visualization techniques and modeling. A collaborative learning model that is represented by young mathematicians and statisticians working closely together with deeply experienced professionals is a combination that can make magic through mentoring and partnering.

V. Competitive Analytics

While context, patterns, and connections are important to design thinking they are also a critical triad in "competitive analytics" [2] and the emerging field of "visual analytics" [45]. Analytics can be applied to many business processes to gain competitive advantage and is a key element in Boeing's innovation agenda. Analytics means "the extensive use of data, statistical & quantitative analysis, explanatory and predictive models to drive decisions and actions" [2]. Analytics creates and then operates on models that reflect patterns and trends that provide insight into areas of leverage and potential advantage in a particular competitive arena. An integrated system of explanatory and predictive analytics structured through dynamic simulation and scenario planning strategic analysis is a powerhouse of knowledge acquisition tools. These tools can be turned on to not only out-know the competition about a particular technology or product direction, but also can be leveraged toward revenue generation. Knowing the customer, being able to provide customers with critical predictive information on, for example, elements that disrupt their income stream, not only enhances the customer relationship but can, in some instances, be offered as a new product line.

Clearly, we're drowning in data. We have data about data about data (meta-meta data). Data is straining the capacities of our databases and repositories. But the critical data, the data that gives us a competitive edge, is difficult to identify. The ability to mine and exploit data is actually quite a recent phenomenon and has emerged from the alignment of three stars: (1) a new generation of technically literate executives, (2) the dramatic expansion of capabilities in analytical software, and (3) the optimization of hardware technologies and database management systems [2]. What started out as decision-support systems in the 1960s to enable investment portfolio management and other organizational decision making tasks morphed into what came to be called executive support systems that mainly focused on performance reporting. In the 1980s, the work of Edward Tufte brought popular attention to the power of visual representation of complex information sets to expand what is knowable [46]. As data volumes increased, largely due to the proliferation of enterprise computing systems, managing data took center stage in the 1990s. As computing power grew exponentially over the following decade, the marriage of analysis, graphic images, and massive data volumes became feasible.

Business Intelligence has been identified as the #1 priority for IT organizations [47]. What is termed Business Intelligence "incorporates the collection, management, and reporting of decision-oriented data as well as analytical techniques and computing approaches that are performed on the data" [2] to enable better decision making. But these technology solutions were not originally developed to enhance competitive advantage. They were focused narrowly on enhancing internal functional operations and are one or two levels removed from advancing the success of the business in the marketplace. They were not designed to drive a company's competitive strategy.

Companies that have moved beyond data mining and management to quantitative and qualitative analysis and visualization techniques integral to the corporate strategy are companies that are exploiting knowledge for competitive advantage. For example, one can understand that accurate reporting to regulatory bodies and shareholders is an important function of publically held companies. Analytics certainly are used to report financial results. But if we look for competitive advantage there, can we see where an application of strategically designed analytics to more accurately predict quarterly revenues might have positive effect on share price over time? The knowledge that would enable this capability must come from experienced subject matter experts but the analytical expertise can come from new hires that are paired up with the knowledge holders in a mentoring/partnering relationship. This extends and sustains the critical intellectual capital value chain.

The process of designing competitive analytics involves diverse tasks such as (1) understanding historical and current situations, as well as trends and events that led to current situations; (2) identifying possible alternative future scenarios and the signs that one or another of these scenarios is coming to pass; (3) monitoring current events to identify both expected and unexpected events, (4) determining indicators of the intent of an action or an individual; and (5) supporting decision makers in times of crisis [45].

Examples of analytical applications are:

Future-value analysis: The decomposition of market capitalization into current value (extrapolation of existing monetary returns) and future value (expectations of future growth)

Monte Carlo simulation: A computerized technique used to assess the probability of certain outcomes or risks by mathematically modeling a hypothetical event over multiple trials and comparing the outcome with predefined probability distributions

Neural network analysis: Systems modeled on the structure and operation of the brain, in which the state of the system is modified by training until it can discriminate between the classes of inputs

Human social network analysis: A computerized technique used to assess the characteristics of social networks in various situations

Carnegie Mellon University social systems analysis: A computerized technique used to describe the interrelations in a particular organization

Content or textual analysis: Analysis of the frequency, semantic relationships, and relative importance of particular terms, phrases, and documentation in online text

Information visualization: Knowledge representation that combines visualization, human factors, and data analysis for the communication of abstract data relevant in terms of action through the use of interactive visual interfaces. The three goals of visualization are (1) presentation, (2) confirmatory analysis, and (3) exploratory analysis [48].

The emergent field of visual analytics strives to facilitate analytical reasoning by creating software that maximizes human capacity to perceive, understand, and reason about complex and dynamic data and situations and exploits the human eye's broad bandwidth pathway into the mind to see, explore, and understand large amounts of information simultaneously [48]. Visual analytics is a highly interdisciplinary field of research that integrates the cognitive and perceptual sciences; information, geospatial, scientific, and statistical analytics; data management and knowledge representation; and the presentation, production, and dissemination of information [48]. Visual analytics is the design of a capability that turns the 21st century information overload into an opportunity by making knowledge hidden in massive datasets visible and accessible.

The combination of a design culture that relentlessly pursues innovation and creativity and the use of strategically driven analytics is a powerful and dynamic duo. Examples of the high value that analytics can bring to a business include measuring the impact of marketing strategies, predicting customer behavior, analyzing historical trends, anticipating future fluctuations in the marketplace, or helping a customer understand and manage disruptions to their value stream Emergent applications for analytics are allowing companies to not only know more sooner, but to make the leap across the firewall and share and integrate data with their customers and suppliers. This type of information integration is enabling near real-time analysis that short-circuits costly supply chain mishaps and increases innovation in supply-demand dynamics. The development of the "test & learn" culture [2] required to be an analytic competitor begins with the institutionalization of a design culture. In analytics, context is designed by the questions that are asked as the ultimate determiner of what delivers the competitive edge. A core value of continuous learning as a leadership imperative, supported by the deep learning achievable through peer-to-peer, apprentice style mentoring, especially in leading edge technology areas such as analytics, sets in motion a self-organizing and self-sustaining engine of productivity.

The human element in competitive analytics–top mathematicians–are "becoming a new global elite ...every bit as powerful as the armies of Harvard University MBAs who shook up corner suites a generation ago" [49]. A shared value among this young and restless scientific and mathematical elite is their need for an open, close, and trusting relationship culture that encourages risk taking, experimentation, and lifelong learning principles. As we have discussed, a design culture creates such a collaborative, learning-focused environment. Because the increasing need for professionals who can leverage and exploit analytic technologies exceeds the limited number of available candidates, those who serve in these roles today can nurture this human analytical capital through apprentice-style, peer-to-peer mentoring with recent college graduates to sustain and grow this innovation-by-design culture.

VI. Conclusion

Roger Martin, Dean of the Rotman School of Management at the University of Toronto, summed up the business challenge of the 21st century: "Now, it's no longer enough to get better; you have to 'get different'" [50].

Getting different means learning how to turn our information into knowledge, attracting young people to our businesses, having a vigorous and innovative workplace culture, and maintaining dynamic and creative design processes. To grow these differences, we can look to whole systems design as a discipline, relationship building as an operating principle, deep learning as a methodology, and advanced competitive analytics as an innovation engine that, in turn, is energized by a robust design culture.

When it gets right down to it, a whole systems design focus begins with a realization of the interconnected nature of life—represented by the link—that is what makes the Web so profound. The standout firms of the 21st century will be those that recognize they are part of an interconnected web of relationships where the goal isn't to supplement our current management methods with design

methods but to fundamentally re-architect our ways of thinking along with our workplace cultures toward more integrative and holistic principles and practices.

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