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Creating Cognitive Entanglement in DX

A Scientific & Technical Basis for the Creation of Human/AI Work Models

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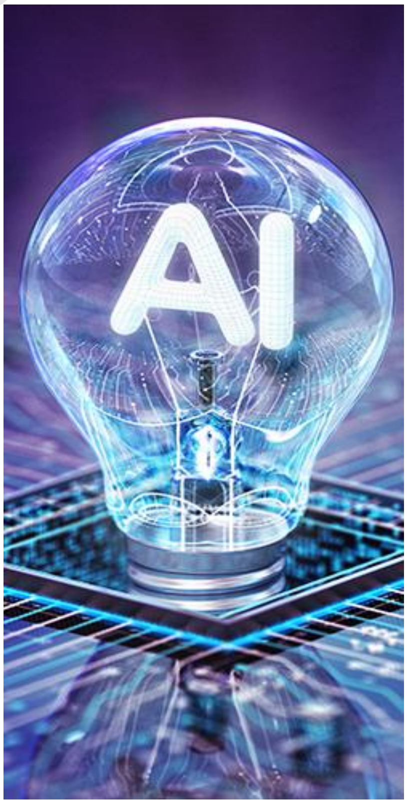

In Digital Transformation (DT) discussions, Artificial Intelligence (AI) often receives disproportionate 'low-resolution' attention from casual observers. DT leaders frequently find themselves compelled to respond to variations of the question, "How are you leveraging and integrating AI?" Observed implementations of AI models in organizations reveal significant technical challenges from engineering and creative production perspectives. Consequently, creating human-AI pairing models yielding more than incremental improvements has remained elusive. Among the many reasons for this are convenient yet incorrect assertions on both ends of the human-AI spectrum. A deep understanding of how AI and the brain differ while complementing each other is central to developing highly impactful human-AI pairing models. Through this crucial principle, it is hypothesized that the most beneficial models of people and AI will be grounded in a form of Cognitive Entanglement, where AI is linked to a unique user at a cognitive level, incorporating a profound understanding of the user's mental and psychological structure, heuristics, intuition patterns, and even decision error tendencies within their specific work domain. At this level, we will create innovative collaboration models between people and AI to achieve 10x improvements and returns.

In its optimal form, digital transformation elegantly codifies and operationalizes the technological components necessary for positioning a firm to achieve clearly defined goals through creating value, solving problems, and fostering future innovation. The unprecedented rise in AI's capabilities ensures a significant role in any DT initiative. Understanding rapidly evolving and not fully comprehended technology and its potential impact on the core cognitive functions of the human brain (also not fully understood) relevant to work roles adds degrees of complexity to an endeavor that frequently falls short of expectations. All indicators point to the well-known McKinsey paper documenting that approximately 70 percent of business transformations fail to achieve their goals, a statistic that is likely to grow.

The often-overlooked human factors are critical to DT and creating new human-AI work models. This highlights one of the most significant shortcomings of DT architects: the failure to acquire the necessary expertise in human factors for integrating technology, which fundamentally mirrors the brain – one of the most complex entities we have ever attempted to understand. Scientific rigor is almost universally lacking when the human factors dimension is incorporated into the larger DT strategy. It tends to address challenges simplistically and superficially. An example is the assertion that "if we make data and information available to people, they will make better, data-driven decisions." While this is a tempting claim, it is contradicted by studies demonstrating the brain's tendency to rely on System 1 (thin slicing) and the associated decision-making errors. This contradiction is also evident at a neuroscientific level in the structure and functioning of brain systems.

A DT-Centric View of AI

AI's rapid rise in capabilities, once the exclusive domain of humans, has sparked essential discussions about its integration within an enterprise digital transformation context. From an enterprise perspective, this conversation is not simple, even if we set aside philosophical topics. However, it is crucial to understand what AI, in its current and evolving form, "is" and "is not" along multiple continuums. AI is expected to equal or surpass human experts in nearly every field – art, medicine, coding, data science, and more – within the next few years. This has fueled apocalyptic thinking about the wholesale replacement of people across every industry; there will be some replacement due to DT, but AI will more likely augment humans, leading to an evolution of work. Strategic planners must note that predictions regarding the extremes of desirable and undesirable outcomes from AI integration have thus far proven false. A significant concern is that evaluations consistently show increased work and cognitive loads on existing employees after AI's incorporation. Ill-conceived notions about how technology should be designed and deployed will only produce undesirable results from the perspectives of human factors, productivity, problem-solving, and innovation. This strongly indicates the necessity of complex scientific inputs regarding human-AI entanglement in DT strategy and implementation plans. The key lies in AI's unique complementarity to the brain and our willingness to explore the Art-of-the-Possible in conceptualizing scientifically supported models of collaboration between the brain and AI.

A Scientific Assessment of AI

The following is a scientifically founded assessment of what AI "IS" and is "NOT" to inform strategic DT discussions.

AI is neither intelligent nor aware; it does not possess understanding, solve problems, make predictions, or remember in the same way that the human brain does. However, AI performs all of these functions differently, achieving exceptional results, which allows it to serve as a unique complement to the human brain. For example, human memory is invariant and time-sequenced, reflecting on itself and piecing together narratives from fragments. It is not designed to remember every detail over time but to retain outcomes from collections of occurrences, enabling us to replicate the good andavoid the bad. In contrast, AI memory can be time-correlated, remembering events and occurrences in intricate detail, and is not invariant (although efforts are being made to change this). Together, the two are extremely powerful, and people have never had access to such a potent complementary tool. The key to unlocking the brain's and AI's potential from a memory perspective – within a broader problem-solving and workflow context- is configuring the UI/UX to enable the AI and the human operator to leverage each other's strengths. There are no shortcuts here; work must be viewed through the lens of both human and AI factors and designed intentionally. The reward will be unique working models that provide competitive advantages.

A second example illustrates how the brain and AI solve problems in different yet uniquely complementary ways. The computational speed of today's massive multi-core AI systems is significantly faster than any biological brain. AI can perform trillions of computations in seconds to address a complex prompt or problem. Conversely, the human brain tackles challenges using memory and typically does not exceed 100 steps. When assessing risk, the brain engages in a process similar to AIs, yet they differ. Simply put, the brain evaluates factors based on memory and belief, correlating events with outcomes by employing multiple organs and systems. In contrast, AI utilizes algorithms and logical processes for problem-solving, including prediction, correlation, perceived causality, and more. We can accurately assert that AI encompasses more than just a set of algorithms; it reasons in ways similar to and distinct from the brain.

Human and computer memory's differing and complementary nature is an essential factor in designing new entanglement models. Human memory is a complicated topic, but simplistically, the brain notes outcomes, events, cause and effect, and correlations to repeat positive and avoid adverse consequences. Our memory is invariant and time-sequenced, meaning it reflects on itself and can piece together a narrative from fragments. Working memory is a conceptual construction with tremendous research validity; it states that the hemispheres each contain a finite amount of memory allocated to the immediate task. The number of items a person can "attend to" is limited. Current research shows the number is between 4-6 depending on numerous factors ranging from IQ to stress. Computer working memory could be a valid construct, but it would be measured fundamentally differently and be vast. The brain constantly learns and updates its reference frames (mental models) to predict what it will see next. All currently in-use AI models are trained in increments, usually coinciding with a significant upgrade.

The statement is often made that "Artificial Neural Nets (ANNs) are designed and function like the brain." This is only true at the highest level of abstraction and misses the central point to complementarity – ANNs and the brain do have to be identical or even the same in a near symbiotic relationship. Vernon Mountcastle, the noted neuroscientist, postulated that the neocortex, despite its diverse functions, operates using a single, fundamental computational algorithm. Mountcastle observed the uniform structure of the neocortex and suggested that the differences in its various regions arise from their connections to other parts of the brain rather than from fundamentally different computational mechanisms. Without going down a rabbit hole, it is evident that AI, in performing higher-order functions – which it now does exceptionally well, does not operate on a single universal algorithm. But again, when paired with a human expert in a field, the two form a unique and skillful combination.

Advanced AI can now perform forensic pathology and make predictions in almost any domain, from medicine to real estate and stock price forecasting. Can AI reason? Yes... but not like the human brain. AI has evolved beyond machine algorithmic, probability, and correlational logic, yet it remains different from human reasoning due to its foundational structure. That said, the differences are shrinking as AI continues to evolve. Combined with complementary technologies such as advanced visualizations, 3D printing, sensors, cyber-physical systems, and human experts, the potential for problem-solving, task execution, and innovation is limitless. The challenge from a DT perspective is that, from an enterprise standpoint, the issue of multiple layers of agents functioning precisely with intent has yet to be resolved.

Of interest to those charged with DT is the ability of humans mated with AI to have nearly infinite knowledge and expertise instantly available and create a cogent level of Situational Awareness and Understanding in a context-dense environment with multiple degrees of separation/correlation between occurrences and outcomes. This applies heavily in areas requiring significant complex reasoning – think M&A's, think Medicine in all its aspects, from diagnosis and treatment to the creation of new antibiotics and equipment. Central to maximizing desirable outcomes is structuring data, analytics, exploring and synthesizing data, and contextual information so that both human and AI interact simultaneously and leverage their goodness.

From a strategic DT lens, today's AI can aptly be described as Advanced Information Processing, Synthesizing, Reasoning, and Production systems versus the general-purpose intelligence of the human brain. When we pair the human brain with AI, we have the most potent combination of problem-solving constructs ever known in human history. The trick is getting it 'right, which requires seeing beyond the obvious into the art of the possible.

AI can be a lateral enabler and multiplier, but not without a deep understanding of the human brain, beginning at the design phase and continuing post-implementation. The most successful digital transformations will be those that can seamlessly create entanglement between people and AI through complementarity. From a design pointof view, it is not difficult to see the potential of creating unique interaction models to leverage each other's goodness. The trick becomes in the details "how" – what would this new working space be for people and AI to come together and become entangled to derive a richness of outcomes.

Entanglement – The Art of the Possible

Dashboards are obsolete. They represent a painful anachronism in the history of technological advancement. Dashboards are artificial constructions and an obelisk of 'abstractism' for the brain. Until about 30 years ago, the brain had never encountered a dashboard. Creating static, two-dimensional objects to represent data starkly contrasts with how the brain has evolved to learn – through movement. To elevate human-AI entanglement, we must reconceptualize UX/UI toward extreme complementarity. This requires designing for memorability, limited working memory, and learning through movement in novel 3D and 2D object spaces. The author does not argue that technology should disappear, as some advocate, but instead evolve, with cognitive neuroscience as one of the foundational pillars for what will be called multi-dimensional object space in the UI.

Since their inception, UIs have struggled to create a unified and robust framework necessary for the brain's understanding, situational awareness, and action-oriented decision-making. Even attempts like the Single Pane of Glass (SPOGs) have fallen short for reasons any decision scientist would readily recognize. The scientific explanation for the failure of SPOGs is that information density exceeded the threshold of working memory, which also appears to have invoked the brain's left hemisphere and its mental model updating mechanism. Yet, firms eager for additional sales were more than willing to introduce them to the market. With the rise of Agentic AI and a deepening understanding of the brain's learning methods, data interrogation, and decision-making processes with data, the way forward involves constructing unique environments for data and information discovery. This approach combines 3D and 2D elements with spatial and semantic dimensions, aligning with Gestalt principles and previously overlooked cognitive aspects such as memorability, integrated with active AI that connects with the user on the most intimate level, factoring in state and trait psychology, heuristic error tendencies, IQ, preferences, and more. Exciting is the fading determinism in requirements or Use Cases. The AI can now ask a set of Use Case questions and build the UI, modifying it according to the direction of the user's interrogation and the AI's perception of what the user should see and explore. We stand on the cusp of forever altering the sensory experience with data and a level of engagement and complementarity previously thought possible in science fiction.

Multi-Dimensional Object Space

AI-dynamically created User Interfaces and User Experiences (UI/UX) will fundamentally alter the sensory experience by dramatically increasing the Information Spectrum being analyzed at speed and scale while reducing entropy from an Information Theory lens. This form of entanglement will significantly affect the firm's use of data, impact situational awareness, and data-driven decision-making along the spectrum of AI to human centricity.

I advance the theory that a multi-dimensional object space composed of visually unique, semantically prototypical features, with physical attributes, functions, and product characteristics nested in space-time, will complement the primary method of reference frame formulation in the neocortex. The more accurate the perception and organization of objects, the more predictive it is of cognitive impact. The intent is to manipulate UI dimensions and features while leveraging organizational principles of perception to enable multi-modal cognition through dynamic user interaction with data and information, mimicking physical movement through an ecosystem. Think of a multi-player video game but instead a hybrid first and third person for a business domain – Sales, Operations, Cyber Security, and so on. At the design level, Relationships such as antonymy, synonymy, hyponymy, usability, and memorability with the ability to explore higher-level semantic and object relations in fine-grained. The AI can simultaneously explore, guide, and highlight any aspect relevant to the user. With the maturing of natural voice, typing and clicking becomes obsolete, effectively removing barriers to cognitive entanglement.

This dynamic multi-layered architecture of interactable visual analytics, metrics, and measures would fundamentally alter the sensor experience with data and likely increase trust as the AI voice explains what is being seen as a supplemental and trusted advisor. This is hypothesized to have a positive impact on the way the brain extends trust to technology. Images have intrinsic memorability, and research shows that the number of semantic dimensions directly correlates with cognitive functioning. Thus, creating a data-dense, multi-dimensional object space of unique 3D and 2D visual analytics, space/time, geolocation, metrics and measures, and contextual text with dynamic exploration functionality may hold the key to a next-generation

UI sensory experience. Time and geolocation also make them excellent choices for immersive data experiences that reveal opportunities, whether to close sales or secure the enterprise. Space-time cubes displaying objects and changes to those objects over time in three- and four-dimensional space could prove transformative for fields such as sales. Geometry-centric Multi-Dimensional Object Space could uncover new opportunities or threats that are not easily visible in two dimensions or tabular data. This is especially true if trajectories, time, and spatial data can be overlaid with metrics, measures, and contextual information of varying degrees of separation for user selection. Imagine the ability to navigate through a cybersecurity device environment by clusters, correlated to other devices by density stack and geolocation, with currently applied patches, in relation to the shifting threat landscape. This view could shift with a single click to a trajectory-based perspective, accompanied by line and time charts and heat maps, all made interactive through data exploration and enhanced by standard two-dimensional charts. This would pave the way for dedicated forms of AI to augment human analysts and decision-makers in unprecedented ways.

In conclusion, AI has become a dominant aspect of enterprise DT conversations, but its deployment in a global enterprise remains a wicked problem. AI is, in many respects, a complex black box of rapidly evolving capabilities, many of which are overstated from an enterprise DT perspective. Furthermore, when discussing AI, human factors are almost universally neglected, and unimaginative models of pairing are often proposed. This approach will likely lead to only incremental advances, as current evidence clearly shows that the opposite outcome – higher work and cognitive loads – is more probable. To realize the full potential of this technology, we must undertake the challenging task of envisioning new human-AI pairings with novel centers of gravity, such as entanglement.