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Reimaging Human-Technology and System Embodied Complimentary

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Despite the advanced multidimensional data visualization and the meticulous development of design methodologies, data-driven decision-making in the most critical areas remains an unrealized goal. The false gods of Data Science and Design, coupled with a general ignorance on the part of corporate leaders of how the brain utilizes and trusts data and technology, is at the heart of this failure. A near purist focus on the data, the models, the algorithms, and visual design methods contributed significantly to this failure.

Both Data Science and UX/UI Design professions lack a deep understanding of how the brain makes decisions, constructs, and accesses memories created from visualization, and critically, how it builds, utilizes, and updates its world models (Reference Frames). Understanding and integrating this understanding of the brain's higher-order thinking into our technology and system building is not just a ‘piece of the puzzle’ but the key to unlocking the potential of data-informed decision-making across the continuum. This understanding is not just important - it is crucial for the future of technology design.

The failure of organizations to engrave “data-driven decision-making in the DNA” of the firm, coupled with the necessity for innovation and problem-solving, underscores the urgent need for advancing human/technology complementarity. The key to re-imagining complementarity in a cyber-physical, data-rich world is to leapfrog current technologies by reimagining the interface sensory experience through a cognitive, psychological, and neuroscientific-based design approach. This novel approach should address as many of the known aspects of the brain's sensory perception, memorability, model construction, and decision-making processes at the neuroscientific, cognitive, and psychological levels as possible. We will not reach the endless potential of human/technology complementarity to solve problems, improve performance, and innovate by continuing to worship false gods. The key to the future is re-imaging the sensory experience and integrating hard science into the next generation of human/technology complementarity.

The ”Abstractism” of UI’s

Today's data-embodied User Interfaces (UI), often referred to as dashboards, represent the pinnacle of “abstractism” to the human brain in its learning, reference frame creation and correction (understanding), knowledge and decision-making processes. The latest treatment of UIs, while having a greater selection of visualizations, remains fundamentally abstract, two-dimensional, and fragmented in their information display. UIs presentation of data and information stands in stark contrast to the brain's natural way of learning and exploring the world, and a dissertation is not required to prove this statement. One only needs to recall how often accurate, precise, and timely data has been disregarded by a decision-maker, to the dismay of witnesses. Date-embodied UIs are “sound bites” attempting to represent a world rich in context and time. As an outcome of their design, dashboards encourage specific thinking. We can equate this thinking to the hemispheres of the brain and the often-witnessed decision errors associated with the brain's hemispheric and system functioning.

The fundamental issue with informing the brain's decision-making processes, intuition, knowledge, and learning through today's Business Intelligence and visual analytics is the lack of *complementarity* between the UI design and the brain's intractable functioning. UX/UI is not predicated on a deep scientific understanding of how the brain learns, interrogates data, creates and auto-corrects reference frames, the memorability of objects, etc.

Learning Through Movement

The human brain's most natural learning method is through movement and dynamic interaction with objects and the environment. Research has shown that movement does not need to be physical, making our creation of UIs immensely powerful. Semantic dimensions such as time, geolocation, objects, edges, etc., are all accurately interpreted and utilized in creating reference frames (mental models) in both physical and virtual worlds. The creation and updating of reference frames in the brain's neocortex is a complex process that is only partially understood. The latest research validates that the brain forms "mental models" from tangible and intangible objects, places, and concepts. Our brain is equally adapted to forming a model of what a tangible thing such as a toothbrush should look and feel like, as it is a purely conceptual concept such as socialism. We see the lack of complementarity when we couple this deep understanding of how the brain learns and informs itself with the current data-embodied UI design. Why "data-driven decision-making" is such an elusive goal with the current tools and techniques suddenly becomes apparent.

The question at hand is can understanding of how the brain functions be applied to reimagine UI/UX design, increase the degree of brain/UI complementarity, and attain defined desirable outcomes such as improved understanding, enhanced intuition, or a reduction in decision errors? To, in effect, redefine the UI sensory experience by moving through data. I propose the answer is a resounding "Yes" through what I will call Multi-dimensional Object Space. I propose the answer is a resounding "Yes" through what I will call Multi-dimensional Object Space.

Multi-Dimensional Object Space (MOS) – Designing Complementarity

An issue with current business intelligence software and the standard dashboard construct is that they often fail to create a unified and robust global perception and organization of objects necessary for action-oriented decision-making. As previously stated, dashboards are purely artificial constructions and a purist form of abstractism to the brain from an evolved perspective of learning and decision-making. To elevate the brain's use of data in organizational decision-making, we must reconceptualize the UX/UI into one of extreme complementarity between tech and the brain. It is not the precept of this author that tech disappears as advocated by some, but rather, it evolves. We can use Cognitive Neuroscience as one of the foundations for what will be termed multi-dimensional object space in the UI.

It is theorized that a multi-dimensional object space of visually unique, semantically prototypical features such as physical attributes, functions, product characteristics, etc., nested in space-time will complement the primary method of reference frame formulation in the brain. 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/information to mimic movement through an ecosystem. At the design level, higher-level semantic and object relations may become 'fine grain. Relationships such as antonymy, synonymy, and hyponymy of both words and objects on usability and memorability in the MOS become essential to test.

The UI's most definitive decision-making aspect is the conceptual visualization of data and information interrogation, augmented with a multi-layered architecture of interactable visual analytics, metrics, and measures. 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 that enables more robust mental model formulation and correction and possibly reduces cognitive load. Cutting-edge research shows that semantic properties impact the brain more than visual properties. However, there is still debate on the roles of low-level visual features such as color.

In conceptualizing this modern UX/UI design treatment, we have many examples of possible structures and visualizations from conceptual artists. These range from modifications of current visual analytics paired with geolocation to artificial constructions such as types of cyber security hardware and patching schedules by location concerning threat or security framework. If this theoretical construction is to become a reality, practical use cases and applications are required and are in no short supply. Fundamentally, almost any use case today will apply as MOS will allow the user to approach the analysis process uniquely differently.

Practical Applications

Rather than approach the MOS conceptualization from a new UI design perspective, let us consider this from a modular addition or App lens. Creating an alternative view where the user can explore the data through movement while retaining the traditional, if less complementary, views of current dashboards may alleviate some of the cognitive load from having to learn new data exploration methods. Switching between conventional dashboards and dynamic constructions of overlapping data and information structures through movement by the user is anticipated to enable abstraction and visual mapping through unique human/AI pairing as never before. Identifying current use cases in tandem with the conceptualization of what moving through data will look like is essential to creating value for the user.

A UI built on embodied complementarity could benefit innumerable areas, two prominent domains that could provide the greatest return on investment are sales and cyber security. These two domains are data-rich and utilize multiple data types, from data tables to telemetry to video. Their use of time and geolocation also makes them excellent choices for immersive data experiences that reveal opportunities, be it to close sales or secure the enterprise. We can easily envision space-time cubes representing objects and alterations to those objects in three- and four-dimensional space. Visualizations based on any of several factors with possible geometry created could reveal entirely new prioritization schemas; think of a geometric threat rating or a geometric prioritization of sales targets as examples. In either of these use cases, the ability to create an accurate and robust link between events and the environment could be game-changing. Especially if trajectories, time, and spatial data can be overlayed with metrics, measures, and contextual information of varying degrees of separation to be selected by the user. Today this is often done ad-hoc through different systems and left to the brain to formulate a mental model, but we can do better. Think of the ability to move through a cyber security device environment by cluster, correlated to other devices by density stack, geo-location, with currently applied patches, and related to the shifting threat environment. This view would be shifted with a single click to a trajectory-based view, accompanied by line and time charts and heat maps, all explorable by moving through the data and augmented by the standard 2-D charts. This would open the door to dedicated forms of Artificial Intelligence (AI) to augment the human analyst and decision-maker in ways currently not being performed. This would also create a degree of complementarity to the brain not seen before in analytics and UI development, possibly shifting the paradigm in organizational disciplines.

Conclusion

In conclusion, this is a conceptual/theoretical article on an evolving line of thinking intended to radically improve how the human brain interacts with data through devices. The intent is to alter the user's sensory experience by enabling movement through data as a form of complementarity to the way the brain learns, creates, and updates mental models. This line of thinking is predicated on deepening cognitive neuroscience understanding while leveraging technology and UX/UI design principles. This novel form of data interaction and display will open the door to focused forms of AI that will range from convolutional neural nets to large language models to answer general questions. This form of data interaction will also open the door to new forms of display, ranging from touch to full holograms to walk-throughs, using touch and voice interaction with the AI. Significant more thought and exploration of this concept has been carried out, but which is impossible to discuss in a brief paper. Still, this is a call to action to develop this concept into a working technology that will elevate existing business intelligence systems and significantly augment dedicated ones in sales, cyber marketing, operations, and more. The author sees the potential of this new form of data interaction as assisting senior decision-makers in domains that require high degrees of complex reasoning and abstract thought, such as strategy and mergers and acquisitions. Due to the nature of decision-making in the brain, these domains often resist data and AI to the detriment of the decision-makers. This inflection point will require leaders and technical experts willing to explore the art of the possible to advance the art of the possible.