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Theorizing Human Information Systems Through the Postmodern Juxtaposition of Quantum Entanglements

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Purpose: In the context of knowledge management, we argue that there is no singular way to understand our own reality because we are constantly entangled in a juxtaposed plurality of postmodern information systems. Humans define their realities and worldviews through culture, ethnicity, language, semiotics, systems of meanings, communities of practice, and other physical and sensory interpretations within information systems. But since multiple factors in time and space define one's information systems, we theorize that alternative interpretive models exist for applications of the same situations when perceived by others.

Study design/methodology/approach: We explored this inherent knowledge management phenomenon of human information systems entanglements through the literature review of respected scientists, theorists, academics, and philosophers; and herein present our theory of entangled human information systems.

Findings: Since all human information systems are dependent upon the continuous management of tacit and explicit knowledge, and the understandings and meanings of the individual experiencing the situation, they may be matrixed, nested, and overlapped with multiple information systems; and because they can exist alone, apart, together, or at different times and places and survive, they are entangled. We theorize that similar to a movable quantum particle, human information systems are also entangled, superpositioned, and juxtaposed in two or more states concurrently; and when interpreted and applied pluralistically, they create an infinite number of simultaneous human information systems in which we reside.

Originality/value: This qualitative approach to inquiry focuses upon understanding the construct of human information systems entanglements and their similarities to quantum entanglements, by exploring the "how" and "why" they occurs, rather than examining the "what" and "how many."

Introduction

Human information, digital and otherwise, is comprised of many dimensions within time and space. These informational dimensions, in the overall context of knowledge management, are matrixed into multiple systems of meanings and understandings based upon a particular situation one experiences or perceives as her or his own reality. But in the postmodern paradigm of plurality, ". . . different people see reality through different lenses and no one reality has precedence over others" (Skovira, 2002, p. 52). These multiple matrixed overlapping information systems concurrently exist in various spheres of reality, contextualized, and interpreted by each individual's social-cultural environment, both independent of and dependent upon one another, and are therefore considered, *entangled*.

The postmodern condition is based upon human knowledge within a particular situation, structural framework, and the social-cultural environment. Humans define their own reality through culture, ethnicity, language, semiotics, systems of meanings, communities of practice, and other physical and sensory interpretations as information systems. Infinite interpretive models exist for applications of the same situations when perceived by others and no two individuals interpret like or similar information in exactly the same way. We suggest that multiple factors in time, space, education, professional career, geographic region, ethnicity, language, age, gender, family, friends, colleagues, social stratum, lived experiences, and so many other factors continually contribute to one's information systems. Human information systems are constantly augmented and evolve through newly obtained information and outside social-cultural influences. Therefore, since all human information systems are dependent upon the understandings and meanings of the individual experiencing the situation, they are matrixed and overlapped with multiple information systems; and because they can exist alone, apart, together, concurrently, or at different times and places and still survive, they are *entangled*.

The state of being entangled dutifully ensnares many conditions and environments regardless of its reliance upon a quantum physics definition or another understanding. However, this paper argues that human information systems are always entangled and juxtaposed within itself and among others, individually, between individuals, within groups, and between groups. *Is this not also the state of a human information system, an encyclopedia of past and present experiences with multiple matrixed, overlapping, and intertwined systems and sub-systems of data? Is an entangled information system not also a juxtaposed complex social-cultural affair?* We explored this inherent knowledge management phenomenon through the literature of, albeit limited to, several respected scientists, theorists, academics, and philosophers; and herein present our theory of entangled human information systems.

Literature Review

Foundational Metaphor: Quantum Computing

Quantum computers perform a type of computation that harnesses the collective properties of quantum states, such as superposition, interference, and entanglement, to perform calculations. Certain calculations and particular algorithms can potentially be done exponentially faster using a quantum computer rather than a silicon-based computer due to the increased power and total number of operations needed. Classical computers operate on and store information in a binary form by manipulating individual bits (Hassija, et al., 2020). Traditional computers in binary form contrast with Quantum computers that implement quantum mechanics to manipulate information using qubits (Egger, et al, 2020). A bit used by classical computers is a 0 or 1 that differs from a qubit in that a qubit can be a superposition or a combination of states (Egger, et al., 2020). It is also possible to apply linear combinations of qubits called entanglements (Egger, et al. 2020).

Bohr (1920) argued that a quantum particle doesn't exist in one state or another, but in all possible states at once. Bohr's theory, also known as the Copenhagen interpretation, called the state of existing in all possible states at once an object's coherent superposition. However, when we physically observe an object, the superposition collapses and the object is forced into one of the states. Bohr's interpretation of quantum mechanics was theoretically proven by physicist, Erwin Schrödinger (1935) with his experiment, Schrödinger's Cat, involving a cat, a box, and a flask of poison. During the cat's stay in the box, it existed in an unknowable state.

This ability of dealing with complex values allows quantum computers to operate with greater speed and efficiency allowing them to solve many complex problems that are not possible with classical computers. Similar to the juxtapositions and entanglements of human information systems, the development of quantum computing opens up a world of possibilities both beneficial and potentially risky depending upon how the capability is applied. In other words, within the quantum world things may not be exclusively black and white, 0 or 1, on or off. Rather they can be both black and white, 0 and 1, on and off, or any micro value in-between. And this is the essence of entanglement.

Entanglement

Entanglement, as constructed by quantum physicists, is defined as a physical phenomenon that occurs when a pair or group of particles is generated, interact, or share spatial proximity in a way such that the quantum state of each particle of the pair or group cannot be described independently of the state of the others, including when the particles are separated by a large distance (Howard, 2007). The quantum state of two or more objects are described with reference to each other, even though the individual objects may be spatially separated or superimposed (Quigley, 2008, p. 604).

Entanglement is everywhere. Einstein, Poldosky, and Rosen (1935) predicted quantum mechanics with correlated systems, but it was Schrödinger (1935) who introduced the term, *entanglement,* with the German word, “Verschränkung.” According to Schrödinger, entanglement, or “Verschränkung,” as translated by Trimmer (1980), was defined as: “If two separated bodies, about which, individually, we have maximal knowledge, come into a situation in which they influence one another and then again separate themselves, then there regularly arises that which I just called entanglement of our knowledge of the two bodies” (1935, p. 844). According to O’Connell (2019), maintaining the delicate state of a superposition and entanglement long enough to run a calculation is a concern in quantum computing. O'Connell further noted that the slightest vibration from a nearby atom can cause a qubit to throw a "quantum tantrum" and lose its superposition.

It is worth considering that the fragile state of a qubit likens itself to the fragility of a human information system whose brain jumps from thought to thought, topic to topic, task to task, sometimes multi-tasking. But other times the human information system completely or absently forgets a thought, topic, or task that was once considered important or significant, and like the fragility of a qubit, decays and is never to be recalled again.

Superposition and Juxtaposition

Dirac (1958) described the general principle of superposition, related to quantum mechanics, as applicable to:

> . . . the states that are theoretically possible without mutual interference or contradiction of any one dynamical system. It requires us to assume that between these states there exist peculiar relationships such that whenever the system is definitely in one state we can consider it as being partly in each of two or more other states. The original state must be regarded as the result of a kind of superposition of the two or more new states. . . . Any state may be considered as the result of a superposition of two or more other states, and indeed in an infinite number of ways. Conversely, any two or more states may be superposed to give a new state. (p. 14)

Stated from a geological perspective of nesting, the law of superposition is based upon a common-sense argument that the bottom layer has to be laid first and is therefore the oldest layer, and any subsequent layers on top of the first layer are therefore younger (Drayer, 2018).

Alternatively, the term juxtaposition arose in common parlance in the early-1900s with origins in Latin and French and attributed to no one in particular, infers a contrast or comparison of things close together or side-by-side (TLFi, 2021). Piaget (1928, pp. 157 - 158) used the term extensively to describe a very young child's lack of logic when attempting to synthesize a concept from a plethora of dimensions (communities of practices, vocabularies, definitions, environments) offered by adults that were confusing, overlapping, and at times, contradictory. Piaget purported that this childhood lack of reasoning was based upon simultaneous juxtaposition and syncretism of more than one concurrent reality. But as adults, do we not also experience this type of information systems entanglement, as well?

From our perspective of a human information system, and similar to a movable quantum particle, information can also be entangled, superpositioned, and juxtaposed in two or more states concurrently. And our theory proposes that human information can be interpreted and applied with multiple meanings in multiple communities of practice, in multiple spaces and places, *concurrently,* thereby creating an infinite number of information systems that are superimposed, juxtaposed, and entangled.

Pluralism

Pluralism is a term used in philosophy, meaning "doctrine of multiplicity," often used in opposition to monism and dualism (Laski, 1925). Although Laski viewed pluralism from the perspective of politics, he nevertheless asserted that multiplicity was its essence and manifestation, always divisible, and could never be a simple exclusive state. Turner (2012) argued that ontological pluralism represents different ways or modes of being that cannot be considered as ranging over a single domain. The term has different meanings in metaphysics, ontology, epistemology, and logic, but primarily it denotes a diversity of views rather than a single approach resulting in competing theories and realities (Skovira, 1989). In his illustration of language games, Wittgenstein (1953*, §68*) argued that that there is no overarching, single, fundamental ontology, but only a patchwork of overlapping interconnected ontologies ineluctably leading from one to another. Wittgenstein purported that it was not possible to identify a single concept underlying all versions of [anything], but that there are many interconnected meanings that transition from one to another. He further offered that vocabulary need not be restricted to technical meanings to be useful, because they are exact only within some prescribed context. This conceptualization of language led to Wittgenstein's assertion that language was also inherently private, with things only known to the user. For example, one's sensations (i.e., pain, taste, etc.) and other subjective experiences, have meanings and definitions applicable to the individual alone. Further, Wittgenstein (1953*, §43*) claimed that the meaning of a word is based upon how the word is understood by the individual and specifically based upon usage, and not upon a universal definition. Laski's and Wittgenstein's theories support our position that multiple meanings of language and understanding are pluralistic and entangled, as both are superpositioned and juxtaposed concurrently within multiple matrixed, overlapping, and nested information systems.

Postmodernism

Lyotard (1979) was attributed to being the first to use the term, postmodernism, in a philosophical context. He built upon Wittgenstein's (1953*, §43*) language of game theory and discussed transformation of knowledge into computer age information. Lyotard defined philosophical postmodernism with: "Simplifying to the extreme, I define postmodern as incredulity towards metanarratives...." meaning there was no metanarrative to define a unified, complete, universal, and epistemically certain story about everything that exists. He argued that postmodernists rejected metanarratives because they reject the concept that truth is always presupposed. Postmodernist philosophers, such as Baudrillard, Derrida, and Foucault (Deely, 2001) generalized that truth is always contingent on historical and social context rather than being absolute and universal; and that truth is always partial and "at issue" rather than being complete and certain.

Rosenau (1992) described the postmodern situation as ". . . intertextuality . . . everything is related to everything else" (p. 33) and is therefore, *interconnected.* She argued that postmodernism was more than a novel academic paradigm because it introduced a radically new and revolutionary movement that encouraged "substantive re-definition and innovation" (p. 4). This philosophy questioned the boundaries of our thinking and knowledge and promoted "complexity rather than simplicity" (p. 8) resulting in relationships of indeterminacy and intertextuality. Marsh (1992, p. 4) depicted "the postmodern situation as one of ambiguity" meaning that a person's knowledge about the world is no longer anchored in one generally applicable theory that provides a unifying explanatory framework. Again, we assert that a person's knowledge of constructed frameworks are interpreted through multiple human information systems and are therefore, *entangled*.

General Systems Theory and the Theorists

The entanglements of Information Systems (IS) are historically linked to Systems Theory (ST) which is commonly defined in the public domain as the interdisciplinary study of systems. Systems are a cohesive group of interrelated and interdependent parts which can be natural or human-made, bounded by time and space, environmentally influenced, defined by structure and purpose, and expressed through its functionality (Meadows, 2008).

General Systems Theory

The term general systems theory (GST) originated from the studies of Von Bertalanffy (1950) and further espoused by other subject matter experts (SME) who supported a variety of scientific disciplines, such as Boulding (1956), Miller (1965), and Bánáthy (1997). Von Bertalanffy (1950) formulated a systems theory, applicable to every scientific field, based upon the complexity of interacting elements, open to the environment, emergence of new properties, and in continual evolution. He further added that a general theory of systems "should be an important regulative device in science . . . [to guard against superficial analogies] . . . that are useless in science and harmful in their practical consequences" (1950, p. 142). Boulding (1956) argued that general systems theory should illustrate open frameworks of interdisciplinary models portrayed as complex hierarchies of empirical information, beginning with the individual, the cell, or the atom. Relevant to humans, the structural framework would then expand upward through interrelationships with groups, organizations, and societies.

A system is generally considered more than the sum of its parts because changing one part of a system will typically affect other parts or the whole system. When a system learns and adapts, its degree of growth depends upon how well the system is engaged with its environment (Von Bertalanffy, 1968). Additionally, some systems support other systems by maintaining each other to prevent failure. The goals of systems theory are to model a system's dynamics, constraints, conditions, and to elucidate principles (such as purpose, measure, methods, tools) that can be discerned and applied to other systems at every level of nesting and overlapping, with the goal in a wide range of fields for achieving optimized equifinality (Beven, 2006).

Equifinality

Equifinality, coined by Driesch and further applied by Von Bertalanffy (1972), is the principle that in open systems a given end state, or goal, can be reached by many potential means and by many ways or paths (Beven, 2006). As a transdisciplinary, interdisciplinary, and multi-perspective endeavor, general systems theory supports our conceptualization of juxtaposed information systems entanglements because it brings together similar principles and concepts to promote both the conscious and the unconscious dialogue between the dependent, semi-autonomous, and autonomous areas of information systems science. For example, a complex, matrixed, and juxtaposition of multiple information systems can be illustrated within the functioning/living human body and are predictable, unpredictable, and *entangled.*

Human Physiology Information Systems

The complex information system of human physiology is comprised of the following ten (10) systems that are completely reliant upon each other and must work together: Circulatory/Cardiovascular; Digestive/Excretory; Endocrine/Exocrine; Immune/Lymphatic; Muscular; Nervous; Renal/Urinary; Reproductive; Respiratory; and Skeletal Systems (Gray, 2020). The brain controls the systems, but the mind controls the feelings, beliefs, values, and the communications. And both are vulnerable to external environmental influences within plural open physiological and psychological human information systems.

Human Behavior Information Systems

According to Miller (1965), general systems human behavior theory is concerned with eight (08) nested levels of living systems—cell, organ, organism, group, organization, community, society, and supranational system. Miller (1972) agreed with other subject matter experts that the diversity of systems is greater than the sum of its parts. But he stressed that: "subsystems were critical because they processed both matter-energy and information" (pp. 16 - 17). And it is clear that Von Bertalanffy's (1950) and Boulding's (1956) general systems theories consistently built upon the learning language theory of Piaget (1928) and the human physiology conceptualization of Gray (1858); and then contributed to the language game theory of Wittgenstein (1953; *§68*); the human behavior systems theory of Miller (1972), the linguistic inquiry system of Bánáthy (1997), and the Human-Computer Interaction (HCI) man-machine systems theory of Newell and Simon (1972).

Systems Inquiry

Bánáthy (1997) argued that the purpose of science was to benefit humankind, with his own significant contribution to the area of systems theory. The linquist purported that the systems' world-view was based upon the discipline of systems inquiry. Central to Banathy's systems inquiry is a configuration of parts connected and joined together by a web of relationships which he directly related to querying systems science, education, and language. This web of relationships aligned itself to Polanyi's (1962; 1966) clear and convincing distinction between tacit and explicit knowledge in concert with corresponding emergent realities comprised of a network of networks. Nonaka's (1994) process encompassed an on-going upward verticle spiral of knowledge entanglements. Subsequently, Nonaka and Takeuchi (1995) further refined the information to knowledge conversion process by their development of the Socialization, Externalization, Combination, and Internalization (SECI) Model representing multiple dimensions of knowledge and understanding.

Critical Systems Thinking

Building upon the theories of general systems and systems inquiry, we offer the concept of critical systems thinking, the ability or skill to solve problems and make decisions in a complex system. As previously noted, a system is an entity with interrelated and interdependent parts; it is defined by its boundaries, open to its environment, and is more than the sum of its parts. Similarly, knowledge is integrated within multiple human information systems through educational, cultural, and physical experiences, providing bridges to multiple levels of understanding and meanings, negating the siloes by leveraging critical thinking (Liebowitz, 2016). Computer system scientists (Söderström, 2010; Charette, 2020) argue that changing one part of the system affects other parts and the whole system, with predictable patterns of behavior. This predictable system of behavior is directly associated with the conceptualization of HCI, the interface of humans with machines (Newell & Simon, 1972: Card, Moran, & Newell, 1983). However, we dispute this theory when it is applied to entangled human information systems, as patterns of human behavior are not always predictable because they are based upon vast interdisciplinary relationships, human inquiry, critical thinking, education, experience, sensory interpretations, and mental analyses and judgments. Contrary to the unconscious applications of most human physiological systems, the conscious human information system can think, choose, and decide from its multitude of interconnected, interrelated, matrixed, overlapping, juxtaposed, and concurrent information systems at its disposal, and is therefore, rarely predictable.

Entangled Human Information Systems - A Theory

Information systems researchers have shown an interest in the notion of sociomateriality, a theory built on the intersection of technology, work, organization, and physical objects in everyday life (Orlikowski, 2010). Sociomateriality focuses specifically on the entanglements described as the inseparability of meaning and matter (Scott & Orlikowski, 2014). Building upon this theory, our particular approach is differentiated by its grounding in an interrelational and performative information society that has been democratized (Beninger, 1986; Negroponte, 1995; Von Hippel, 2005). Specific to our theory of entangled human information systems, democratization of information means that since humans have greater access to all types of information in the Digital Age, they also have the power to interpret the information in multiple ways with the ability to separate meaning from matter in a vast array of nested, matrixed, and overlapping layers of reality. According to Skovira (2001, p. 1): "The details of an individual's life are digitized and stored in a database; the real person becomes a digital person. The real firm becomes a virtual firm." A person's knowledge of the world resides in multiple frameworks of interpretation. We argue that there is no one way to understand our own reality.The Figure below illustrates that we are constantly entangled in a juxtaposed plurality of postmodern information systems.

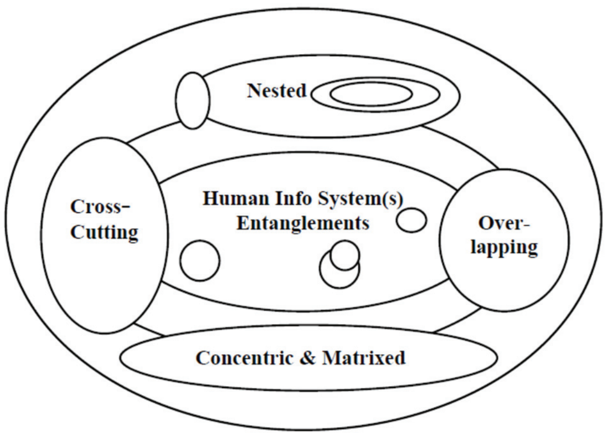

Figure. Human Information System(s) Entanglements

Figure. Human Information System(s) Entanglements

Canevacci (2021) coined the term, *ubiquitimes* to illustrate his construct that digital cultures and communications transform the classical distinction of time and space. Canevacci purports that anthropological methods and ethnographic field work illustrate that polyphonic transfusions in multi-sited situations revolve around space and time relationships. "Ubiquity is uncontrollable, incomprehensible, and indeterminable" (Canevacci, p. 2). Although Canevacci's theory does not cite human information system entanglements, we argue that Canevacci suggests that de-centralized and non-linear human experiences reflect the pluralism and juxtaposition of quantum entanglements. His ethnographic research demonstrates multiple space and time relationships, oscillating between different contexts that co-exist within and outside the identical or different frames. Canevacci describes that: "There is no sociologically defined center, but a differentiated cultural polycentrism" (p. 3). (*As a point of full disclosure, the authors of this paper are also agile on-ground and digital ethnographers; therefore, we further argue that Canevacci's conceptualization further supports our theory that multiple time and space social-cultural relationships are also indicative of entangled human information systems).*

We propose that general systems theory, as applied to human beings, requires systems inquiry, which leads to critical systems thinking, and ultimately devolves into entangled human information systems to solve problems and make decisions. In a purely functional closed system, these events may indeed be predictable; but in an open system environment, *we proffer that events (or results) cannot be entirely predictable,* due to external situations, unforeseen occurrences, outside influences, and the democratization of information.

Our analysis centered on the production of information and its pluralistic interpretations at any one time, place, and space. By examining how information is constituted and shared through an entanglement of meanings, understandings, communities of practice, language games, semiotics, vocabulary, lingo, sensations, and other attributes of physical, mental, sensual, and academic interpretation based upon worldviews, experience, education, and the constant bombardment of new data; we challenge the predominantly social treatments of living within a single information system at any one time and place; and suggest that the truth arises from the insecurities, uncertainties, and inexplicable wonders of living within multiple overlapping, matrixed, and entangled human information systems all the time.

As with any theories, especially those metaphorically related or based on other theories, there are dangers. Precautions need be taken to be aware of 2nd and 3rd order consequences. In the context of a quantum computing metaphor, Gordon (2022) describes this phenomenon as:

> When two qubits are entangled, actions on one qubit can change the value of the other, even when they are physically separated, giving rise to Einstein's characterization of "spooky action at a distance" (personal communication to Max Born, 1947). But that potency is equal parts a source of weakness. When programming, discarding one qubit without being mindful of its entanglement with another qubit can destroy the data stored in the other, jeopardizing the correctness of the program.

While entanglement may be described as an inherent characteristic of human interaction with each other and the world, we must remain aware that human information system context may be lost or damaged.

Conclusion

We argue that there is no singular way to understand our own reality because we are constantly entangled in a juxtaposed plurality of postmodern information systems. We explored some of the key ideas of entanglement through a comparison of multiple information systems that are concurrently realized by the digital person in a complex society of infinite information. We compared human information systems entanglement to general systems theory, systems inquiry and critical thinking, human physiology, behavioral psychology, language and linguistics systems, human-computer interaction, and the physical phenomenon of quantum mechanics.

The quantum state of plural human information systems may occur concurrently and be superpositioned or juxtaposed; but the real human dilemma is which reality (understanding or interpretation) to select and act upon at any given time.

Humans define their own reality and worldviews through culture, ethnicity, language, semiotics, systems of meanings, communities of practice, and other physical and sensory interpretations as information systems. But since multiple factors in time and space define one's information systems, interpretive models exist for applications of the same situations when perceived by others. Therefore, since all human information systems are dependent upon the understandings and meanings of the individual experiencing the situation, they may be matrixed and overlapped with multiple information systems; and because they can exist alone, apart, together, concurrently, or at different times and places and still survive, they are *entangled*.

Socially situated communities of practice are generally associated with narrowly-focused ethnicity, language, and cultural mores. But we argue that communities of practice are drivers of learning and knowledge existing in a variety of environments, relationships, and spatial positioning and could significantly influence socially situated knowledge management systems. The topology is dynamic and the spatial and relational proximity of communities of practice can be near, distant, or in both or multiple places at once. Again, human communities of practice are overlapping, matrixed, nested, concurrent, singular, ever present, and most definitely *superpositioned* and *entangled*.

From our perspective, we suggest that similar to a movable quantum particle, human information systems can also be entangled, superpositioned, and juxtaposed in two or more states concurrently. Our theory proposes that information can be interpreted and applied pluralistically with multiple meanings in multiple communities of practice, in multiple times, spaces, and places, *concurrently,* thereby creating an infinite number of nested and layered human information systems. We reside within these complex information systems, are reliant and dependent upon them, and when one component or subsystem fails we do our best to mitigate the failure with memories of lived experiences, prior education, subject matter experts, communities of practice, social-cultural mores, language, common-sense, instinct, and the utilization of the constant bombardment of new information.

We realize that there are vast dimensions of knowledge management in terms of human information systems in our Digital Age, and they all deserve further research and discussion. We intend to further explore our information systems entanglement theory by interviewing subjects and observing their behavior within formal Case Studies and Ethnographies. Descartes (1644) summed up his construct of human truth, existence, inquiry, and profound doubt about everything with: "Cogito ergo sum." *However, we propose that there are countless entangled human information systems behind that theory.*

References

Bánáthy, B. A. (1997). Information, evolution, and change. *Systems Practice, 10*, 59-84.

Beven, K. (2006). A manifesto for the equifinality thesis. *Journal of Hydrology, 320*(1), 18-36.

Beniger, J. (1986*). The control revolution: Technological and economic origins of the information society.* Harvard University Press.

Bohr, N. (1977). Some Considerations of atomic structure: Lecture delivered before the Physical Society of Copenhagen, 15 December 1920. In *Niels Bohr Collected Works* (J. Kalckar, Editor), Vol. 4, p. 43-69. Retreived from Elsevier: https://doi.org/10.1016/S1876-0503(08)70114-2

Boulding, K. E. (1956). General systems theory: The skeleton of science. *Management Science, 2*(3), 197-208.

Canevacci, M. (2021). Digital ubiquity. *Academia Letters*, Article 1264. DOI: https://doi.org/10.20935/AL1264

Card, S., Moran, T., & Newell, A. (1983). The psychology of human-computer interaction. Lawrence Erlbaum Inc.

Charette, R. (2005, Oct.). Why software fails. IEEE Spectrum, 42(9), 42-29.
Deely, J. (2001). *Four ages of understanding: The first postmodern survey of philosophy from ancient times to the turn of the twenty-first century.* University of Toronto Press.
Descartes, R. (1644). *Principia philosophiae*. Ghent, Belgium: Apud Ludovicum Elzevirium. [Original published in Latin; Translated to French by A. C. Picot in 1647]
Dirac, P. (1958). *The Principles of Quantum Mechanics* (4th ed.). Oxford University Press.
Drayer, D. (2018, May 28). *What is the law of superposition and how can it be used to relatively date rocks?* Retrieved from: https://socratic.org/questions/what-is-the-law-of-superposition-and-how-can-it-be-used-to-relatively-date-rocks
Egger, D. J., Gambella, C., Marecek, J., McFaddin, S., Mevissen, M., Raymond, R., Simonetto, A., Woerner, S., & Yndurain, E. (2020, October 13). Quantum Computing for Finance: State-of-the-art and future prospects. *IEEE Xplore.* Retrieved from https://ieeexplore.ieee.org/document/9222275.
Einstein, A., Podolsky, B., & Rosen, N. (1935). Can Quantum-Mechanical Description of Physical Reality be Considered Complete? *Phys. Rev., 47*(10), 777-780. Retrieved from: doi:10.1103/PhysRev.47.777.
Gray, H. (2020). *Gray's Anatomy: The Anatomical Basis of Clinical Practice* (42nd ed.). (S. Standring, Ed.). Elsevier USA. [Original publication 1858]
Gordon, R. (2022, January 24). A New Language For Quantum Computing. *MIT News.* Retrieved from: https://news.mit.edu/2022/new-language-quantum-computing-twist-0124
Hassija, V., Chamola, V., Goyal, A., Kanhere, S. S., & Guizani, N. (2020, November). *Forthcoming applications of quantum computing: Peeking into the future*. Retrieved from https://ietresearch.onlinelibrary.wiley.com/doi/epdf/10.1049/iet-qtc.2020.0026
Howard, D. (2007). The early history of quantum entanglement: 1905 - 1935. *TAM 2007*. August 28, 2007.
Laski, H. (1925). *A grammar of politics.* George Allen & Unwin Ltd.
Liebowitz, J. (2016). *Successes and failures of knowledge management*. Elsevier.
Leidner, D., & Kayworth, T. (2006). A review of culture in information systems research: Toward a theory of information technology culture conflict. *MIS Quarterly, 30*(2), 357-399.
Lyotard, J-F. (1979). *The postmodern condition: A report on knowledge*. University of Minnesota Press.
Marsh, J. L. (1992). *Modernity and its Discontents* (J. D. Caputo and M. Westphal, Eds.). Fordham Univ. Press.
Miller, J. (1965). Living systems: Basic concepts. *Behavioral Science, 10*(3), 193-237.
Miller, J. (1972). Living systems: The organization*. Behavioral Science, 17*(1), 1-182.
Negroponte, N. (1995). *Being digital*. Vintage Books.
Newell, A., & Simon, H. (1972). *Human Problem Solving.* Prentice-Hall.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science, 5*(1), 14-37.
Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: How Japanese companies create the dynamics of innovation.* Oxford University Press.
O'Connell, C. (2019, July 5). Quantum computing for the qubit curious: Quantum computers could change the world. *The Science of Everything Cosmos*. Retrieved from: https://cosmosmagazine.com/science/quantum-computing-for-the-qubit-curious
Orlikowski, W. (2010). The sociomateriality of organizational life: Considering technology in management research. *Cambridge Journal of Economics (34)*1, 125-141.
Piaget, J. (1928). *Judgement and reasoning in the child*. Routledge & Kegan Paul Ltd.
Polanyi, M. (1962). Tacit knowing: Its bearing on some problems of philosophy. *Reviews of Modern Physics, 34*(4),
601-616.
Polanyi, M. (1966). *The Tacit Dimension*. London: Routledge. (University of Chicago Press 2009 Reprint)
Quigley, M. (2008). *Encyclopedia of Information Ethics and Security.* IS Ref - IGI Global.
Rosenau, P. M. (1992). *Post-Modernism & Social Sciences: Insights, Inroads, & Intrusions*. Princeton Univ. Press.
Schrödinger, E. (1935). Die gegenwärtige Situation in der Quantenmechanik. *Die Naturwissenschaften, 23*, 807-812, 823-828, 844-849. Retrieved from: https://doi.org/10.1007/BF01491914
Schrödinger, E. (1935). Discussion of Probability Relations Between Separated Systems. *Proceedings of the Cambridge Philosophical Society, 31*, 555-662.
Schrodinger, E. (1935). The present situation in quantum mechanics: A translation of Schrodinger's "Cat Paradox" paper. (Trans. J. D. Trimmer). Translation originally published in *Proceedings of the American Philosophical Society, 124*, 323-338. Retrieved from: http://hermes.ffn.ub.es/luisnavarro/nuevo_maletin/Schrodinger_1935_cat.pdf
Scott, S., & Orlikowski, W. (2014). Entanglements in practice: Performing anonymity through social media. *MIS Quarterly, 38*(3), 873-893.
Skovira, R. J. (1989). Pluralism in information science. *Bulletin of the American Society for Information Science, 15*(5), 18-19.
Skovira, R. J. (2001). A postmodern conception of information. [Unpublished Manuscript, c. 2001]

Skovira, R. J. (2002). A conception of information for a postmodernist information science. *Proceedings:Faculty of Arts of Comenius University in Bratislava Historica, Library & Information Science, XIX*, 49-62.

Söderström, J. (2010). *F-ing shit system! Stockholm: Karneval Förlag.*

Stevanovic, A. (2016, August 11). Cultural entanglement. *New Materialism EU Almanac*. https://newmaterialsim.eu/almanac/c/cultural-entanglement.html

Tresor de la langua francaise informatise (TLFi), also known as, *The digitalized treasury of the French language*. Retrieved February 11, 2021: http://www.tlfi.fr/historique.htm (Original publication 1971)

Trimmer, J. (1980). The Present Situation in Quantum Mechanics: A Translation of Schrödinger's "Cat Paradox" Paper. *Proceedings of the American Philosophical Society, 124*(5), 323-338. Retrieved October 17, 2020 from: http://www.jstor.org/stable/986572

Turing, A. M. (1950). Computing machinery and intelligence. *Mind,* 59, 433-460.

Turner, J. (2012). Logic and ontological pluralism. *Journal of Philosophical Logic, 41*, 419-448.

Von Bertalanffy, L. (1950). An outline of general system theory. *British Journal of the Philosophy of Science, 1*, 134-165.

Von Bertalanffy, L. (1968). *General systems theory: Foundations, development, application*. Braziller.

Von Bertalanffy, L. (1972). The history and status of general systems theory. In G. J. Klir (Ed.), *Trends in General System Theory* (pp. 407-426). Wiley-Interscience.

Von Hippel, E. (2005). *Democratizing innovation*. The MIT Press.

Wittgenstein, L. (1953). *Philosophical Investigations (§43 & §68).* Macmillan Publishing Company. [Translated from German to English by G. E. M. Anscombe]