Human-Centered Symbiotic System Science

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Abstract— **In previous paper we showed that Symbiotic System Science (SSS) is a growing scientific area which is taking a leadership role in fostering consensus on how best to bring about symbiotic relationships between autonomous systems. Capitalizing on SSS insights and development, the recognition that SAS (Symbiotic Autonomous Systems) are poised to have a revolutionary impact on society over the coming years is quite straightforward. The promise of SSS is to reveal a convenient roadmap to arrive to Human-centered Symbiotic System Science (HCSSS) to develop more reliable Human-centered Symbiotic System (HCSS), to fully utilize the capabilities of cognitive computing and brain-inspired system as support for more effective application of our higher human faculties. In present paper we discuss HCSSS to bring about symbiotic relationships between HCSS, as evidenced by the living human brain modalities, supported by the *CICT* OUM framework.**

Keywords—Cognitive computing; computational intelligence; brain-inspired system; information systems; cognitive robotics; symbiotic system science; autonomous system.

I. INTRODUCTION

In different paper we presented and discussed main considerations on Autonomous System (AS), Symbiotic System Science (SSS) and SAS (Symbiotic Autonomous Systems) [1]. The development of the new field of SSS will allow to consolidate and advance technological and managemental expertise with emphasis even on Ethical, Legal, and Societal (ELS) implications, and with the objective to promote fundamental human-centric economic and social growth [2]. The promise of SSS is to reveal convenient roadmap to arrive to Human-centered Symbiotic System Science (HCSSS) to develop more reliable Human-centered Symbiotic System (HCSS), to fully utilize the capabilities of cognitive computing as support for more effective application of our higher human faculties.

Current paradigms of SAS are such as natural intelligence systems, social computing systems, man-machine systems, cognitive robots, bioinformatics systems, brain-inspired systems, self-driving vehicles, unmanned systems, intelligent IoT, cyber-physical-social systems, cognitive systems, etc. Cognitive systems are based on Cognitive Informatics (CI) [3]. It is a transdisciplinary field that studies the internal information processing mechanisms of the brain and their engineering applications in cognitive computing and computational intelligence. Cognitive Computing (CC) is a cutting-edge paradigm of intelligent computing methodologies and systems based on CI, which implements computational intelligence by autonomous inferences and perceptions mimicking the mechanisms of the brain. CI and CC not only synergize theories of many modern information science areas, but also reveal exciting applications in cognitive computers, cognitive communications, computational intelligence, cognitive robots, cognitive systems, and the AI, IT, and software industries [4].

In present paper we discuss HCSSS to bring about symbiotic relationships between HCSS as evidenced by the living human brain modalities. HCSS application can thrive on either Person-Centered System (PCS) [5] or Social-Centered System (SCS) resources [6], supported by the *CICT* Computational Information Conservation Theory) OUM (Ontologic Uncertainty Management) framework [7],[8]. Future papers will address PCS and SCS properties in detail.

Today, disruptive technologies are appearing at an accelerating pace. Blockchain, quantum computing, augmented analytics, IoT and artificial intelligence (AI) will drive disruption and new business models. These technologies offer even greater potential for enhancing productivity and quality of life and liberating human beings from physical, social and mental tasks that can be performed with equal or greater speed and quality by machines. Liberated from the monotonous, repetitive drudgery of the routine, they make it possible for us to explore and develop higher relational, emotional, intellectual and creative capacities which are uniquely human. But, if we manage the incoming FIR with the same blindness and forms of denial with which we managed the previous industrial revolutions, the negative effects on our society will be exponential [5]. At social level, inequality and unemployment destroy opportunity freedom. Radical inequality significantly undermines opportunity freedoms and capacity freedoms, and consequently radically undermines human capital as a foundation of community prosperity [6].

We need to reframe uncertainty-as-problem in the past into the evolutive concept of uncertainty-as-resource. The key change performance factors are knowledge and education, solving the major "information double-bind" (IDB) problem in current most advanced research laboratory and instrumentation system, just at the inner core of human knowledge extraction by experimentation in current science [9].

It is the fundamental dichotomy distinguishing classic, contemporary education from a new one, based on a more reliable control of learning from uncertainty and uncertainty management; discriminating information building on sand (in the past) from information building on rock (in the future).

It implies the building of precision driven, intrinsic limitations to the traditional, cultural project of reducing a complex environment to its simpler, formal representation, "The Real to Reality" by rationality. In this process, we need to be deeply aware of the fundamental difference between approximated approximation (AA) and exact approximation (EA) representation. In the first case (AA), as in sound and utterance for spoken language or in Analytical Calculus by the truncation of Taylor series (with the approximated error expressed by the related order of magnitude only), we can develop the statistical or stochastic approach with either the Bayesian or the frequentist perspective. In the second case (EA), as in Geometry or in Arithmetic by arresting the expansion of Geometric series at a desired point (with specific error knowledge expressed by an exact value), we can develop a corresponding combinatorial approach [8]. When we discuss about the exact numerical approach to the reality, we are not acting as mystical Neopythagoreans; instead, we are analyzing how the numerization process is created and how the rules work with digits and numeric words [10].

We are talking about a natural property of the cognitive systems (to deal with quantities) that has been heavily improved with symbolic and algebraic tools at rational level in the past. But traditional, formal symbolic tools are a clever operational compromise that emphasizes main superficial relations only. As it is well known, they overlook the related, deep full relational (one-to-all) ordering of specific arithmetic structures underlying our human representation rational framework. We need to understand much better their relational, complementary articulations by new eyes [7],[11-13]. Only then, we will be able to reach the root of digit deep meaning and be ready to fully reconnect the never disjoined non-dual dichotomy between human being and his/her universe in the unity of Nature [13].

As a matter of fact, to grasp a more reliable representation of reality, researchers and scientists need two intelligently articulated hands: both stochastic and combinatorial approach synergistically articulated by natural coupling [13]. Education has to be reconceived from the ground up: solid scientific education, in both the natural biology grounded in anticipation, and the real physics of the world, is required.

Present planetary problems are multiscale-order deficiencies from the past, and obsolete, Western reductionist worldview. They cannot be fixed by the usual, traditional, hierarchical approach alone, by doing what we do better or more intensely, but rather by changing the way we do it. We not only need more education but education that is qualitatively different, a new paradigm in education: the "consilient education" [14]. In fact, updating course content or devising new modalities of knowledge delivery is not enough.

For instance, imagine a world where affordable, quality healthcare is available to every person, and where infectious disease and infant and maternal mortality are as rare in the poorest parts as they are in wealthier countries. Achieving health and wellbeing for all will require a change in mindset. We must examine the barriers that deny health care to so many others. Such barriers can take different practical, cultural, or social forms, but identifying them can inform the development of new tailored solutions. This new mindset will require a shift in business models too. Instead of seeking solutions that have the greatest utilitarian value, it could be better to look for innovative solutions that have an intended disproportionate impact, largely benefiting the few rather than the many.

This in itself is a high-order endeavor, since schools continue to indoctrinate new generations in the traditional religion of reductionist, classical physics, biology and chemistry. To minimize or overcome major system limitations and to arrive much closer to reliable and resilient HCSS, we need to extend our traditional system model representation understanding first, taking into consideration quantum field theory (QFT) main interactions conveniently, even at macroscale level [15].

It is hard to make prediction on the long-term effects of disruptive technologies and in general scientists are not good in that. In 1933, Ernest Rutherford famously stated that the transformation of atoms would never result in a source of power. Nevertheless, as we contemplate the inevitable transition from an age defined by electron-based tools to one informed by biological tools, we too will be hard pressed to predict the ultimate outcomes, risks, and benefits that this new biological tool kit will bring to humankind. In the 1950s, a new generation of interdisciplinary researchers set out to break down the biological world into parts and rules. Building on the 1944 discovery that DNA was the "transforming principle" and chemical substance of genes, pioneers formulated a new digital age, based not on the binary code script of computing machines but on the sequences of nucleotide bases. The elucidation of this biological parts list, along with an unprecedented ability to manipulate it, has taken humankind to the cusp of a second convergence at the interface of biology and engineering.

One thing is quite clear, today intellectual leadership in knowledge can no longer be separated or divorced from social responsibility for its impact, be that at either environmental or societal level or both. No longer is it possible to maintain the artificial and illusory division between the development of knowledge and the policy implications of its application. This is specifically true for incoming HCSSS and HCSS [16].

II. Towards HCSSS ans HCSS

Before going in deeper detail on HCSSS main considerations and remarks to bring about symbiotic relationships between HCSS supported by the *CICT* OUM framework [7],[8], it is better to have a clear idea on the fundamentals of the symbiosis concept. The adjective symbiotic derives from the noun Symbiosis. Symbiosis is any type of a close and long-term biological interaction between two different biological organisms, be it mutualistic, commensalistic, or parasitic. The organisms, each termed a symbiont, may be of the same or of different species. In 1879, Heinrich Anton de Bary defined it as "the living together of unlike organisms". The term was subject to a century-long debate about whether it should specifically denote mutualism, as in lichens; biologists have now abandoned that restriction [17].

Symbiosis can be obligatory, which means that one or both of the symbionts entirely depend on each other for survival, or facultative (optional) when they can generally live independently. Symbiosis is also classified by physical attachment; symbiosis in which the organisms have bodily union is called conjunctive symbiosis, and symbiosis in which they are not in union is called disjunctive symbiosis. When one organism lives on the surface of another, such as head lice on humans, it is called ectosymbiosis; when one partner lives inside the tissues of another, such as Symbiodinium within coral, it is termed endosymbiosis.

Historian Jan Sapp has said that "Lynn Margulis's name is as synonymous with symbiosis as Charles Darwin's is with evolution" [18]. In particular, Margulis transformed and fundamentally framed current understanding of the evolution of cells with nuclei, an event Ernst Mayr called "perhaps the most important and dramatic event in the history of life", by proposing it to have been the result of symbiotic mergers of bacteria. Margulis was also the co-developer of the Gaia hypothesis with the British chemist James Lovelock, proposing that the Earth functions as a single self-regulating system, and was the principal defender and promulgator of the five kingdom classification of Robert Whittaker.

Margulis' work on symbiosis and her endosymbiotic theory had important predecessors, going back to the mid-19th century, notably Andreas Franz Wilhelm Schimper, Konstantin Mereschkowski, Boris Kozo-Polyansky (1890-1957), and Ivan Wallin. Margulis took the unusual step of not only trying to promote greater recognition for their contributions, but of personally overseeing the first English translation of Kozo-Polyansky's “Symbiogenesis: A New Principle of Evolution,” which appeared the year before her death in 2011.

Symbiogenesis, or endosymbiotic theory, is an evolutionary theory of the origin of eukaryotic cells from prokaryotic organisms, first articulated in 1905 and 1910 by the Russian botanist Konstantin Mereschkowski, and advanced and substantiated with microbiological evidence by Lynn Margulis in 1967. It holds that the organelles distinguishing eukaryote cells evolved through symbiosis of individual single-celled prokaryotes (bacteria and archaea).

Among the many lines of evidence supporting symbiogenesis are that new mitochondria and plastids are formed only through binary fission, and that cells cannot create new ones otherwise; that the transport proteins called porins are found in the outer membranes of mitochondria, chloroplasts and bacterial cell membranes; that cardiolipin is found only in the inner mitochondrial membrane and bacterial cell membranes; and that some mitochondria and plastids contain single circular DNA molecules similar to the chromosomes of bacteria.

Man-machine symbiosis was a concept first proposed by Joseph Licklider at a time when AI was in its early years. His seminal work on the subject, in 1960 [19], discussed several of the issues appearing when trying to augment human capabilities through a close interaction with computers. The idea was too much ahead of its time as the technology to solve those issues was not yet at hand. Research on man-computer symbiosis is moving forward at a good pace and a community of researchers in the field has consolidated into an informal research network of academic and industrial research groups investigating the symbiotic dimension of human-computer relations [20]. Symbiotic Interaction proceedings are available online [21].

Our perspective is based on capitalizing on SSS insights and development to recognize that SAS are poised to have a revolutionary impact on society over the coming years. Currently, communities and global organizations are conducting ongoing efforts in the area of autonomous and intelligent systems which are converging towards SAS, supported by the SSS concept [22].

Economic and societal forces, enabled by the evolution and convergence of several technologies, are driving the development of a novel generation of systems. Today, we are at a crossroads, on the cusp of significant transformative changes that will impact society worldwide, revolutionizing global business operations and fundamentally altering how inanimate objects are perceived in a world increasingly reliant on autonomous systems. Deeper reality understandings, new effective multidisciplinary, interdisciplinary and transdisciplinary competences are already strongly required, in the business, technical, management and social communities especially, at all levels and scales.

Emerging symbiotic systems focus on enhancing the relationship between human beings and machines rather than on designing machines to operate as autonomous agents only. Therefore, for us a symbiotic system is a bio-and-social-inspired system characterized by heterogeneously synergized, adaptive structures and behaviors. One possible AS evolution is SAS to arrive to HCSS.

Most AI systems currently act as a complement to humans instead of replacing them, much like symbiotic organism and system in nature. Traditional theories and technologies perceive AS as human-system interactions where humans are "in-the-loop" or "on-the-loop. In the coming decades we are bound to see progress in both the "computerization" of the world and in its digitalization. These two trends will strengthen one another and will overlap creating the age of real "intelligent" systems. A classification of "intelligent" systems may be determined by the forms of input (Event) and output (Behavior) [1] under system internal uncertainty management algorithms [23]. As a matter of fact the current situation is under a strong evolutive push to pass through SAS and SSS [22] first, to arrive to Human-Centered Symbiotic Systems (HCSS) and Human-Centered Symbiotic Systems Science (HCSSS) eventually [16].

One thing is quite clear, the maintenance of a pole position in this new frontier of human accomplishment will require an infrastructure that fosters interdisciplinary and transdisciplinary projects, encourages curiosity-driven science, cultivates a diverse scientific workforce, and encourages financial instruments that facilitate long-term returns.

Most AI systems currently act as a complement to humans instead of replacing them, much like symbiotic organism and system in nature. HCSSS aims at bridging the existing gaps between the various disciplines involved with the design and implementation of so-called "intelligent computing systems" (AI based, deep learning, etc.) that support current human's activities. Meanwhile, it is a set of methodologies that apply to any field that uses computers in applications in which people directly interact with devices or systems that use computer technologies to senses patterns in human behavior and then enable adjustments to adapt and optimize their mutual interactions. Neuroscience hypothesizes that consciousness is generated by the interoperation of various parts of the brain, called the neural correlates of consciousness or NCC, though there are challenges to that perspective. Proponents of Artificial consciousness (AC) believe it is possible to construct systems (e.g., computer systems) that can emulate this NCC interoperation.

III. Artificial Consciousness

Artificial consciousness (AC), also known as machine consciousness (MC) or synthetic consciousness, is a field related to AI and cognitive robotics. The aim of the theory of artificial consciousness is to "Define that which would have to be synthesized were consciousness to be found in an engineered artifact" according to Igor Aleksander in 1995 [24],[25]. Consciousness for AI would mean that ANN (Artificial Neural Network) could make their initial choices by themselves, deviating from the programmers' intentions and doing their own thing. Machines will become conscious only when they start to set their own goals and act according to these goals, rather than do what they were programmed to do. This is quite different from autonomy: even a fully autonomous car would still drive from point A to point B as told. One of the pitfalls for machines before becoming self-aware is that consciousness in humans is not well-defined enough, which would make it difficult if not impossible for programmers to replicate such a state in current algorithms for AI.

The scientists defined three levels of human consciousness, based on the computation that happens in the brain [26]. The first, which they labeled "C0," represents calculations that happen without our knowledge and awareness, such as during facial recognition, and most traditional AI products function at this level. The second level, "C1," involves a so-called "global" awareness of information, in other words, actively sifting and evaluating quantities of data to make an informed, deliberate choice in response to specific circumstances. Self-awareness emerges in the third level, "C2," in which individuals recognize and correct mistakes and investigate the unknown.

What we call "consciousness" results from specific types of information-processing computations, physically realized by the hardware of the brain. It differs from other theories in being resolutely computational; we surmise that mere information-theoretic quantities [27] do not suffice to define consciousness unless one also considers the nature and depth of the information being processed. Although centuries of philosophical dualism have led us to consider consciousness as unreducible to physical interactions, the empirical evidence is compatible with the possibility that consciousness arises from nothing more than specific computations [11], [28],[29].

Once we can spell out in computational terms what the differences may be in humans between conscious and unconsciousness, coding that into computers may not be that hard. To a certain extent, some types of AI can evaluate their actions and correct them responsively. But do not expect to meet self-aware AI anytime soon. While we are quite close to having machines that can operate autonomously (self-driving cars, robots that can explore an unknown terrain, etc.), we are very far from having conscious machines and real living human brain modalities.

IV. Living Brain Modalities and Expertise

History will credit Stéphane Lupasco for having shown that the logic of the "included middle" is a true logic, formalizable and formalized, multivalent (with three values: A, ¬A (non-A), and T) and non-contradictory [30]. His philosophy, which takes quantum physics as its point of departure, has been marginalized by traditional physicists and philosophers. Curiously, on the other hand, it has had a powerful albeit underground influence among psychologists, sociologists, artists, and historians of religions.

A current example, in the computational area, has been developed by *CICT*, where digit, digit-word, operator, data, information are self-defined bottom-up by their own resonant behavior with all other numerical entities, in an included relational way (one-to-all) [7], [11, 12]. They are types of knowledge themselves or something used to attain new knowledge, applying the fundamental four transformation operators I (identity), N (negation), R (reciprocation) and D (duality) [31]. Then *CICT* allows for a controllable, graded transition from the cosmic non-dual dichotomy (traditionally interpreted as the elementary dichotomy vital to binary logic) to everyday, human multi-valued logic. Here, the key, hidden parameter is "discrete precision" [32] to make the quantum leap from quantity to quality [12].

"Information understanding" demands placing something in a restricted context. Information understanding cannot exist without its own context and vice-versa. It is like an "Application" that interacts within its own operative "Domain". Experience is always gained when an Application is developed to interact within a Domain, and a Domain is always developed or investigated by a scouting Application [23], [31]. In terms of ultimate truth, a dichotomy of this sort has little meaning but it is quite legitimate when one is operating within the classic mode used to discover or to create a world of "immediate appearance" by narration. In other words, by the use of *CICT*, to capture the full information content of any elementary symbolic representation, it is necessary to conceive a "quadratic support space" at least. Of course, we can apply our dichotomizing process in a recursive way to achieve any precision we like.

As an operative example, we can start to divide human experience into two non-dual, irreducible, interacting concepts or parts, "Application" and "Domain". According to *CICT*, the full, evolutive information content of any embodied, symbolic representation emerges from the capturing of two fundamental, coupled components: the linear component (unfolded) and the nonlinear one (folded). This is the root, the fundamental cosmic non-dual dichotomy of any human representation. Referring to the transdisciplinary concept [33],[34] we see that for full information conservation any transdisciplinary concept emerges from two pair of fundamental coupled parts. In turn, both Domain and Application can be thought of as being either in "simple mode" (SM, linearly structured, technical, unfolded, etc.) or in "complex mode" (CM, non-linearly structured or unstructured, non-technical, folded, etc.) representation, as defined in Fiorini [35]. The SM Application or Domain represents the world primarily in terms of "immediate appearance", whereas a CM Application or Domain sees it primarily as "underlying process" in itself. CM is primarily inspirational, imaginative, creative, intuitive; feeling rather than facts predominate initially.

"Art", when it is opposed to reductionist "Science 1.0" is "feeling transmission" rather than "data transmission." It does not proceed by data, reason or by laws. It proceeds by feeling, intuition and aesthetic resonance [36]. The SM, by contrast, proceeds by data, reason and by laws, which are themselves underlying forms of rational thought and behavior. Therefore, we can assume, for now, to talk about human brain experience by referring to SM and CM, Application and Domain, according to the Four-Quadrant Scheme (FQS) of Fig. 1.

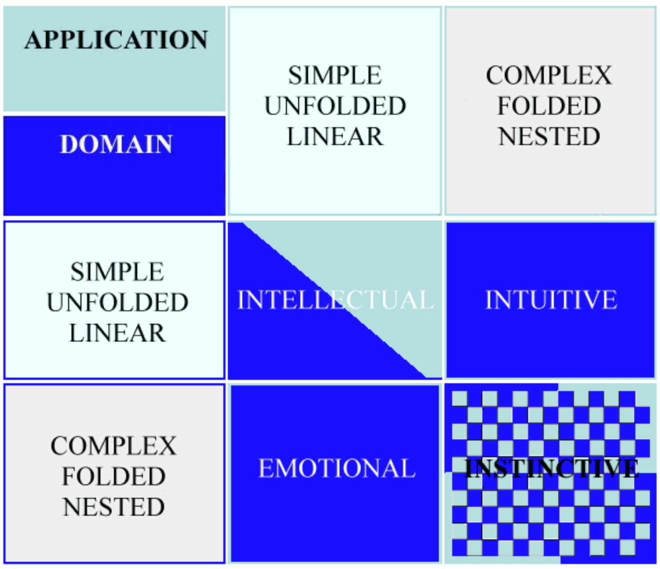

Fig. 1. Living Human Brain Four-Quadrant Scheme (FQS). The four natural modalities of human mind: Intuitive, Intellectual, Emotional and Instinctive, according to *CICT* OUM framefork [7],[8],[32],[37] [(see text)..

Whatever your goal is, think about whether you are going to need intellect, intuition, emotion or instinct or an aggregation of them, in order to achieve it. Those are the main four natural modalities of our thinking mind. From a common language perspective, taking into consideration the folding and unfolding properties of *CICT* structured "OpeRational"(OR) representations for the Space-Time Split (STS) [37], one can conceive a better operative understanding of usual terms, with the added possibility of increased information conservation, referring to those four natural modalities of our operative brain. Here, the term "INTUITIVE" (Fig.1, first quadrant, top right) is considered the combination of a major unfolded time representation framed by folded minor space representation. The term "INTELLECTUAL" (Fig.1, second quadrant, top left) is interpreted as the combined representation of major unfolded space and time representations, with minor complementary folded time and space components.

The term "EMOTIONAL" (Fig.1, third quadrant, bottom left) can be assumed as the combination of a major unfolded space representation framed by the minor folded time representation. The forth quadrant (Fig. 1, bottom right), "INSTINCTIVE" represents the combination of major folded space and time components, framed by the combination of minor unfolded space and time components. It can be interpreted as the simple (bidimensional), but realistic representation of the usual modality experienced by any living organism. Moreover, it can help us to better understand and to be deeply aware that our skin is the functional, semipermeable closure of our entire nervous system and brain (they all are generated by the same one of the embryo's three primary germ layers, the "ectoderm"). Their deep, related implications shape our ability to feel ourselves comfortably immersed within our own universe and survive [31],[38].

Philosophers and scientists have across the ages been amazed about the fact that development and learning often lead to not just a merely incremental and gradual change in the learner but sometimes to a result that is strikingly different from the learner's original situation: amazed, but at times also worried. A seminal brain imaging study comparing brain activation patterns in novices and experts performing identical tasks showed that increased expertise correlated with drastic changes in functional brain anatomy. Indeed, the differences were so large that the authors concluded that novices seem to perform outright "different tasks" from those that experts do: the functional anatomy of experts was both more efficient and task-relevant networks were more associated with other, potentially relevant, functional networks [39]. Such empirical perspectives give some insight into what happens when a novice is transitioning to a stage of expertise. We are apparently capable of accomplishing drastic changes in our behavior and cognition and in the processes subserving these. As positive as this may sound, these changes have also raised concerns.

The main concern is whether gaining expertise is like raising a "cognitive monster" which escapes the individual's conscious control and influences her actions with undesirable automatisms [40]. Nevertheless, an empirical study showed that there are ways to regulate and control the automatized and unconscious processes involved [41]. However, the warning against monstrous behavior is still partly justified and should encourage paying attention to the processes involved in developing and employing expertise. Studies have indeed demonstrated that expert performance is optimal under certain conditions only, because it is limited to a specific restricted domain, often context-dependent, biased and inflexible, like a highly reductionist worldview [42]. In situations that are relatively common, experts outperform novices, yet in more exceptional situations their performance is less optimal, demonstrating the "brittleness" of their expertise [43]. Therefore, educating novices should equally entail two faces of expertise: establishing both (1) the specific resources that experts rely upon for their specific cognitive and behavioral performances as well as (2) the metacognitive and practical skills to employ those resources in a regulated way or to intentionally modify situational or pragmatic conditions such that standards or goals are met [44].

In modern times, specialization has overtaken broader fields of knowledge and multidisciplinary research. The mental world we live in today is infinitely divided into categories, subjects, disciplines, topics, and their more and more specialized subdivisions. Our past knowledge is organized into "silos": good for grain, not for brain. Therefore, their consilience is quite poor. Forcing societies to fit their knowledge into boxes with unrelated arbitrary boundaries, without understanding deep reasons for them, may lead to serious consequences, like those we witness in many world affairs today. specialization has overtaken broader fields of knowledge and multidisciplinary research. To overcome the missing path dependence problem, interdisciplinary and transdisciplinary education are really the ways society, together with scientists and scholars, must move on.

The domain is then no longer specified only in terms of industrial development and political consequences, but also in terms of the three subdynamics of the evolutionary Triple Helix model [45]: (1) knowledge production, (2) wealth generation, and (3) regulation. Since 2008, nations like Qatar have been already preparing for a change, as it seeks to move from a petroleum-based to a knowledge-based economy, according to "Qatar National Vision 2030" planning. [46],[47].

Therefore, the "Mindustrial Revolution" [48] has to be a reliable creative thinking transformation process by more and more integration of wellbeing signatories and ratifiers from different cultures and countries. In order to achieve an antifragile behavior, next generation human-made system must have a built-in, new fundamental component, able to address and to face effectively the problem of multiscale ontological uncertainty management.

V. Conclusion

The final goal of HCSSS is to formulate theoretical and practical knowledge required to maximize security, human welfare and individual wellbeing of all humanity in a manner consistent with universal human rights, cultural diversity and civilizational values and what it will mean to live in harmony with Nature.

The goal is not to discover immutable, universal, natural laws based on any existing precedent, model or theory, but to identify the laws and first principles of social system suitable for promoting global human welfare and wellbeing.

Ray Kurzweil's prediction that computers will have the same level of intelligence as humans by 2045 may accurately reflect the amazing speed of technological development and the enormous scope for further advances in AI and Cognitive Computing [49]. But it grossly underestimates the true and full capabilities of human consciousness of which these achievements will still represent only a minor aspect. The error comes not in estimating the power of technology but in underestimating the power of people. The promise of SSS is to reveal a convenient roadmap to HCSSS, to fully utilize the capabilities of cognitive computing as a support for more effective application of our higher human faculties.

The maintenance of a pole position in this new frontier of human accomplishment will require an infrastructure that fosters interdisciplinary and transdisciplinary projects, encourages curiosity-driven science, cultivates a diverse scientific workforce, and encourages financial instruments that facilitate long-term returns. Today intellectual leadership in knowledge can no longer be separated or divorced from social responsibility for its impact, be that at either environmental or societal level or both. No longer is it possible to maintain the artificial and illusory division between the development of knowledge and the policy implications of its application. This is specifically true for incoming HCSSS and HCSS able to take into consideration even quantum system properties at macroscale level [15].

Values express intention and commitment, but they are not merely utopian ideals or ethical principles. They represent the highest abstract mental formulations of life principles with immense power for practical accomplishment. They represent the quintessence of humanity's acquired wisdom regarding the necessary foundations for human survival, growth, development and evolution.

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