Leadership in Cognitive Computing and its Social Consequences

Garry Jacobs
Chief Executive Officer
The World Academy of Art and Science
Napa, California, USA
garryjacobs@gmail.com

Abstract— **This paper examines critical intellectual and social challenges on the emerging frontiers of research in the field of symbiotic systems such as Artificial Intelligence and Cognitive Computing. Leaders will need to address these issues as they seek to enhance the application of cognitive technologies to promote human welfare and well-being in an increasingly complex and integrated global society. These leadership issues arise from the social consequences and policy implications of emerging technologies as well as profound intellectual questions on the frontiers of knowledge concerning human consciousness and intelligence.**

Keywords— symbiotic systems, leadership, integration, decision-making

I. Introduction

Both theoretical and practical advances in Artificial Intelligence and Cognitive Computing over the past decade have been rapid and remarkable. Applications relating to facial, fingerprint, voice, speech and text recognition, autonomous vehicles, personalized learning, gamification, customer interactions, medical diagnosis and recommendations, crop protection, self-checkout retailing, market research, news analysis, and movie-making are illustrative. New applications are continuously extending the reach of these technologies into new fields. The speed of their dissemination, social acceptance and integration reflect the immense practical benefits they offer.

Throughout history, technology has been a principal driver of human development and social evolution. The labor-saving technologies of the first and second Industrial Revolution reduced the physical drudgery of both work and life in earlier times, raised productivity and living standards, introduced unprecedented comforts and conveniences, and marked the transition of human labor from a source of physical energy measured in terms of horse-power into higher forms of social and human capital. This transition placed a rising premium on the development of social and mental knowledge and skills. Education and training became essential requirements for younger generations to keep pace with the rapidly changing social needs and potentials. These developments shifted the focus to higher order abilities for problem-solving, decision-making and innovation, which distinguish us from other species and in that sense spur us to become more truly human. But the transitions of the past have never been smooth. They generated widespread fear, uncertainty, discontent and resistance. The slow pace of societal response to technological change resulted in destruction of traditional modes of employment, displacement of people, poverty, alienation, social unrest and violence. They spurred the rise of authoritarian governments. In an effort to stem the rising appeal of communism in the West, they led to efforts to humanize capitalism through programs such as the New Deal and the social democratic policies prevalent in Europe in the post-World War II period.

Emerging symbiotic systems focus on enhancing the relationship between human beings and machines rather than on designing machines to operate as autonomous agents. 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. At the same time, the speed, power and social consequences of recent technological advances in AI and Cognitive Computing pose serious challenges which need to be urgently addressed by leaders in the field. Published research by respected institutions such as McKinsey and World Economic Forum, aggravated by extravagant techno-visionary hype and public hysteria, are already raising widespread concern that continued advances in these fields will radically alter, invade and take over more and more of both the workplace and our private space, making even higher human faculties redundant or obsolete, rendering people unemployed, unemployable and unnecessary [1].

These concerns are fueled by both realistic and exaggerated claims and fears. Studies predicting a radical disruption of global job markets in the next two decades may or may not turn out to be accurate, but the impact of these studies on social attitudes and human security is already a real and present threat that is disillusioning youth, polarizing democratic societies, spurring the rise of populist leaders, fostering social alienation, crime and drug abuse. Governments are already responding and reacting to increasing public pressure to impose regulations to protect society from unbridled application of technologies with such profound social impact. This tendency is likely to grow and spread rapidly unless its root causes are addressed. But a crucial challenge is that regulations do not keep pace with technological advancement, which makes us question whether regulators really understand their role and need to update themselves with evolving times.

This presents technology leaders with a serious dilemma. What should be the role of technology leaders in addressing these real and imaginary consequences and their real impact on social stability and human welfare? Should leaders continue to concentrate solely on developing the potentials of the emerging technologies in the field, lobbying for industry self-regulation, and opposing increasing government intervention? Or should they shift focus from exclusive attention to playing a leadership role in exploiting technological and business opportunities to promoting the ideal mix of technology, regulation and other policy measures required to maximize social welfare and wellbeing? The first option has been the traditional response and it has always aggravated the transition of society. The latter would position them as true leaders of global social evolution and take them outside the conventional sphere of their activity. They may end up lobbying for higher taxation on the wealthy as Gates and Buffett are doing or higher corporate income and capital gains tax to more widely distribute 8the benefits of technology to the general public. Or advocate introduction of a basic minimum income program for all citizens. Some technology leaders have already recognized and accepted this shift in roles and embraced them at least hesitantly.

Until recently scientists could claim and did that they were not responsible for the social consequences and policy implications of their research findings. That was the responsibility of business leaders who decide how these technologies are deployed and political leaders who decide how they are regulated. This position is no longer tenable. Intellectual leadership in knowledge can no longer be separated or divorced from social responsibility for its impact. The tendency of mind to divide reality into parts and treat each as a separate and independent field of knowledge is the root cause of the compartmentalized, fragmented approach to scientific research, education, policy-making and commercial activity that has predominated until now. No longer is it possible to maintain the artificial and illusory division between the development of knowledge and the policy implications of its application. The World Academy of Art & Science was founded sixty years ago by eminent scientists and social leaders who realized the need for leadership to address this Cartesian divide.

Given the speed and enthusiasm that presently fuels research and application of these advances, it would be naïve to underestimate or dismiss either the fears or their potential impact on future public opinion and policy-making. The speed of technological advances far outpaces the rate with which educational and other social institutions change and develop. Changing social institutions and public policies is a slow and long process. Already our educational institutions, even the finest of them on the leading edge of research, lag hopelessly behind the emerging needs of individuals and global society in the 21st century. Technological illiteracy is only a tiny portion of the problem. At a time when work itself may soon become obsolete, our social sciences continue to study and prepare youth based on flawed theories utilizing outdated pedagogical methods. Cultural change in attitudes and values is much slower and longer, disrupting social processes and exasperating the tensions wrought by rapid technological innovation. This developmental mismatch is the source of rising social concerns, tensions and real-world impact on the lives of a growing number of people. Evolving appropriate responses to them represents one of the next crucial frontiers and defining issues for technological leadership in the 21st century.

The danger that humans beings could one day be replaced by machines and rendered obsolete may be true, but the source of the problem lies in human beings, not in the machines they fashion for their use. If there is any threat to humanity, it will not come from a conspiracy of superior intelligent machines that take over the planet, but rather from human beings who consciously and willfully surrender their independence and humanity to that which they have created or permit social agents to impose them. And this danger is real and ever-present. Technological leaders of the future will need to understand this truth just as Steve Jobs understood both the real threat and growing public anxiety regarding the rapid adoption of computers to replace human beings in the 1970s.

It will not be sufficient for future leaders to choose wisely and responsibly what technologies to develop and disseminate. Their greater challenge will be to assume responsibility in consciousness for actions and consequences beyond their immediate power to prevent or control. The artificial walls separating invention from application are crumbling. Ignorance is no longer an excuse. Technological leaders can no longer cede responsibility to politicians, law-makers and enforcers. They must become active lobbyists and outspoken proponents of regulatory policies which will promote the wellbeing of society and not just the bottom line. The first who need to free themselves from subservience to the alluring power of technology are its leaders and innovators.

II. Intellectual Leadership Challenges in the Social Sciences

AI and CC are fast approaching the boundaries of a very different type of leadership challenge waiting to be tackled in the future – one which will prove far more difficult to comprehend and successfully address, but also one which offers the greatest potential for the future evolution of technologies, society and the human race. In this case also, the social implications and consequences are immense, for they relate to our concept of the very nature of our humanity and the dimensions of it which society seeks to develop in future, as we have so powerfully developed our tool-making and linguistic capabilities in the past. Here the challenge is primarily intellectual and technological, rather than political, legal and social. This challenge concerns the very nature of human reasoning, logic and consciousness on the one hand and the nature of social reality, human accomplishment, welfare and wellbeing on the other. It encompasses the entire range of the social sciences in the next or a more distant frontier of discovery. It calls for radical advances in the premises, concepts and theories by which science tries to comprehend the nature of human consciousness, society and life itself.

Here the leader approaches the very frontiers of humanity's knowledge about its own existence, both as individually and collectively. Knowledge in the social sciences lags far behind developments in the natural sciences and it is a common error to adopt simplistic concepts that treat social and psychological reality in the same manner as physical systems by utilizing the same concepts and reliance on quantitative measures developed over centuries and used so successfully in the natural sciences. 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 [2]. 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 Symbiotic Systems is to fully utilize the capabilities of cognitive computing as a support for more effective application of our higher human faculties.

A. *Complexity*

The difficulty arises due to fundamental differences between the natural and social domains of study. The first of these is complexity. The social sciences are concerned with phenomena that are orders of magnitude more complex than anything that exists in the purely physical realm of natural science. This complexity arises from the multiplicity of variables that have to be taken into account, which make even complex calculations relating to the movement of objects, projectiles and ballistics relatively simple by comparison. Meteorological predictions are notorious instances of complexity in the natural world, but they are dwarfed by the complexity of relatively simple human situations. This complexity arises because not only are human problems subject to a multiplicity of physical conditions, forces and circumstances, but they are also influenced by an even greater number of social and psychological factors to which physical systems are not subjected. For example, the treatment of physical disorders is compounded by the impact of prevailing social beliefs regarding the disease, the mode of treatment and the physician who administers the cure as well as the fears, emotions, hopes, expectations, opinions and attitudes of the patient, family members and health care administrators about the safety and efficacy of outcomes. Extensive research on the placebo effect in medical treatment is illustrative, e.g. 50-75% of the efficacy of antidepressant medication in major depression is due to a placebo effect [3].

The shift in emphasis from autonomous decision-making systems to symbiotic systems that make recommendations is a very welcome and important development. However, the tendency to regard the computer recommendation as somehow superior because it is based on a huge sample of data undermines the exercise of the function of the clinician to assess precisely those aspects of reality that are not and cannot be captured by the data. The problem is reinforced by the influence of insurance companies that pressurize hospitals and clinicians to play the odds rather than learn and be trained to trust in the unique human capacity to escape the heuristic of bounded rationality characteristic of computerized decision-making systems [4].

B. The Power of the Subtle and Subjective

The second complication arises from the subtlety of non-physical social, emotional, and mental factors which makes them extremely difficult to access and measure. Significant progress is being made to measure superficial human responses in the fields of Emotional AI and Affective Computing, which may be useful to gauge responses and respond to people in well-defined situations. But measuring momentary emotive responses and even more deeply entrenched attitudes and options, represents only the tip of the iceberg. They only detect surface manifestations of psychological responses. They do not take into account the complex array of factors that define and determine human conditions, consciousness and responses. The common remedy is to ignore those factors that do not readily lend themselves to measurement and statistical analysis. Diagnostics and prescriptive systems in healthcare inevitably place emphasis on measurable physiological variables and obvious behavioral factors such as food, alcohol and drug consumption. They are unable to adequately handle the subtlety of factors such as financial matters, divorce, bereavement, loneliness, depression, and unemployment; still less, self-reliance, self-confidence, cheerfulness, fear and faith which may have profound impact on the prognosis. Leadership will be needed to advance research on the interaction of physiological, psychological and sociological factors rather than rely on systems that reduce the issue to conveniently-measurable terms.

The same problem exists in dealing with social issues such as economic and political behavior and management, which are very largely governed by social and psychological factors. This is why the efforts of the US Federal Reserve to contain and reverse the US banking crisis after 1929 failed to stop the panic which resulted in the bankruptcy of 10,000 banks in three years. When Franklin Roosevelt became President in 1933, he dispensed with reliance on conventional economic theory and policy-measures. He understood that both the problem and the solution were social and psychological. Instead he directly appealed to the American people to restore their faith and self-confidence in the country and urged them to redeposit their hard-earned life-savings in the bank. Within a week, the panic abated and the crisis was overcome [5].

The inadequacy of existing social theories and models is also illustrated by two striking instances in which the predictions of financial and industry experts proved to be uniformly wrong. Both in the case of Chrysler Corporation in the early 1980s and Apple in the mid-1990s, the experts predicted failure. Yet after approaching the verge of bankruptcy and in spite of ever-growing competition from Japanese imports, Chrysler was able to convert record losses – the largest by any corporation in history up to then -- into record profits – more than all it had earned in the previous six decades [6]. When Steve Jobs returned to Apple in 1996, the company was a high-priced commodity computer maker with rapidly declining market share. Michael Dell, founder of the PC industry leader at the time, advised Jobs to liquidate the company's assets and return whatever remained to the shareholders while there was still something left. Within a decade Apple was well on its way to becoming the most valuable company in the history of the world. These remarkable turnarounds are illustrative of the importance of subjective factors in business which so often falsify conclusions drawn from past performance and the state of the balance sheet.

Similar errors are well-known in the military field. Clausewitz confirmed Napoleon's assessment that psychological factors could offset as much as a three to one advantage in terms of military strength [7]. Tolstoy described the same phenomenon in War and Peace, as the spirit of the army. Shakespeare immortalized it in King Henry V's famous speech before the battle of Agincourt, in which a depleted and exhausted English army defeated a battle-ready French force two to four times larger and inflicted casualties ten to twenty times greater. Hitler and his general staff underestimated it when they assessed that Britain would surrender within the first three months of Germany's invasion. Yet within that same time span, it was Germany which lost the Battle of Britain.

Cognitive Computing can provide valuable assistance to human decision-making to the extent that it can discover ways to expand the horizon of research and application beyond the limitations physical data, sensory input and even the monitoring of physiological functions. Inclusion of subjective variables will help human beings become more conscious of the importance of their own ideas, opinions, attitudes, values and emotions in determining the quality of the choices they make and the outcomes they achieve. In that sense, our machines can help us become more conscious human beings and indeed more human than otherwise.

C. Individuality & Uniqueness

These examples also point to a third obstacle encountered in the social sciences, which further compounds the difficulty. It is the problem of individuality. Objects in physical nature belong to various types – quarks, electrons, protons, atoms, molecular compounds, etc. This typal character of the objects enables science to regard them as identical and interchangeable with others of the same category. Whereas when it comes to human beings, no matter how similar they may be, the physical characteristics, habits, skills, abilities, capacities, knowledge, beliefs, emotions and values of a group of people, each has a discernible individuality or uniqueness just as he or she has a unique fingerprint, even in the case of biologically identical twins raised in the same environment. Psychology has worked for over a century on psychological typologies – the universal attributes of human nature, the distinction of psychological types, the variation due to education and culture, and the imprint of upbringing and experience all may lend themselves to categorization, but none of them constitutes a full and effective representation of human personality. Indeed, there is not even a definition of human personality that adequately encompasses its physical, vital-social, emotional, mental and spiritual dimensions. Each of these planes of human existence can be subdivided into subplanes – such as the physical mind used in engineering and planning, the emotional mind of the poet, the aesthetic mind of the artist, the ethical mind of the moralist, the pure thinking mind of the philosopher and many more.

Furthermore, the variations between individuals are increasing rapidly, as people are exposed to an increasing variety of environments, enlarged network of contacts, higher levels of education, media, travel, inter-cultural contacts, personal wider life experience and the more rapid development of the societies in which they live. Iacocca and Jobs not only falsified the prognosis of financial experts, but also illustrate the power of a single individual or small group to radically transform social outcomes. Napoleon, Churchill, FDR, Gandhi and King Henry V may have identifiable typal qualities but they are each unique as is Shakespeare's greatest character Falstaff and Mr. Collins in Jane Austen's Pride and Prejudice.

The effort of social science to reduce individual differences to qualitative categories and quantifiable measures has produced useful concepts and practical tools, but they operate within severe limits. The notable failure of online dating sites to design algorithms that can effectively match human beings in terms of long term compatibility is based on naïve simplistic notions both of what constitutes individuality and compatibility. The reality of individual uniqueness may be viewed as an obstacle by those trying to design systems to assess, anticipate and influence human behavior, but it is also the key to human inventiveness, creativity and evolution. Technology leaders must keep ever in mind the difference between the mental representation and the reality, between the movie and the real world.

Nor can the individual be abstracted from the people with whom he lives and works and the time and place within which he was born, raised, lives and acts. Adding or removing a single factor can radically alter the logic and arithmetic. What is the logical answer to the equation 1 + 1 = when each single digit represents a complex living being? What would Steve Jobs have accomplished in the 1970s without his partnership with Steve Wozniak? Or in the 1980s without the ideas and operational models he inherited from the work of Douglas Engelbart two decades earlier at SRI? The individual and society, person and context are inseparably inter-dependent on one another. That multiplies the difficulty of assessment and decision-making. The individual is at once a product of the society and circumstances and the catalyst and leader of all social change. The interaction between these two poles – individual and collective – constitutes the dynamism of our species and the spur to our continuous evolution. The army without the leader and the leader without the army are two very different realities. That explains why great leaders throughout history seem to emerge in groups at the same time as Washington, Jefferson, Franklin, Hamilton and others did in revolutionary America and Gandhi, Nehru and Rajaji did to lead India's fight for Independence.

The difficulty posed by the complexity of the interaction between unique individuals and unique circumstances is illustrated by the circumstances and controversy which surrounded the fate of US Airways Flight 1549 on January 15, 2009. This was the flight piloted by Captain Chesley Sullenberger which suffered sudden failure of both engines after being hit by birds 80 seconds after takeoff from LaGuardia Air Port in New York with 155 people on board. Sullenberger had 208 seconds from that moment to assess the options and act before the plane crashed. Counter-manning the instructions of airtraffic controllers and contrary to the consistent recommendations by computerized flight simulators after the event, Sully decided to risk a very dangerous, nearly always catastrophic, water landing, rather than attempt to make an airport landing. The simulations based on accurate data on the altitude, velocity and distance of the plane concluded that the safest course was to return to the nearest airport. Nor did they factor in the real risk of high fatalities to land-based individuals as the result of a premature landing in a crowded urban area before reaching the runway. It was finally determined that the decision Sully made was the only one that could possibly have been successful [8].

D. Values

Sully's remarkable achievement points out a fourth factor in human decision-making which is even more difficult to render through any existent type of cognitive systems. It is the question of values. What no computerized system could possibly take into account was the value of saving 155 human lives and possibly more in the event the plane landed in a congested urban neighborhood near the airport. The classic example of automotive companies calculating the relative cost-benefit of reducing safety risk versus allotting funds to cover legal and insurance coverage and that of medical insurance companies considering the cost-benefit of different types of medical treatment illustrates the difficulty in relying on computer systems to make decisions or even recommendations that involve the lives of human beings or the required value judgments regarding the value of intangible factors such as the public trust in banks and government, individual freedom of choice and preference in education or occupation, and other fields. Human life is pervaded by subtle value judgements that have no equivalent in the purely physical world.

A few small examples should be sufficient to illustrate the magnitude of the challenge in designing systems that truly replicate the capabilities of human intelligence. Sherlock Holmes was able to discover the murderer in Arthur Conan Doyle's story "Silver Blaze" because he understood the significance of the dog that did not bark. Mr. Collins was incapable of understanding why Elizabeth Bennet refused his marriage proposal in Pride & Prejudice when all his rational faculties assured him she could not expect a more eligible candidate and better offer. When he was asked by the press on becoming the new president of the University of Hawaii who would take decisions in the university, Harlan Cleveland retorted, "Who takes decisions in your home?" These challenges argue compellingly for a shift in focus to viewing cognitive technologies as one element in a wider system in which the role of the human consciousness and agency is of paramount importance.

III. Beyond the Frontiers

All of the factors discussed in this paper have direct and central importance to the application of cognitive computing for the development of effective systems for decision-making and decision-recommendation. Computer systems have proven invaluable for their capacity to manage complex physical systems more rapidly and effectively than human controllers. Yet the limitations of computer aided decision-making become apparent when they are applied to issues that involve human beings for all the reasons discussed above. The number, variety and complexity of the interaction between social, psychological and physical variables defy rendering by existing technologies. The subtlety of the factors involved, the uniqueness of individual agents and social situations, and the subjective assessment of values add to the difficulty.

A. Science of Human Accomplishment

But beyond these there is one further obstacle. While the laws governing physical interactions between objects and complex systems such as climate are either known or in the process of being discovered, the principles governing human accomplishment are yet to be seriously studied or codified. Raw material from history, biography, literature and contemporary events abounds, but the study and interpretation of this material to derive fundamental principles of a science of human accomplishment lie in the still distant future. Social science has largely contented itself with reducing human beings to their physical counterparts rather than dealing with the dimensions that make them truly human and unique.

But this does not mean that the application of cognitive computing has no role to play in this field in future. On the contrary, leadership in this field could make an immense contribution to unravelling the intricacies of human actions and outcomes. While autonomous computerized decision-making systems may be inappropriate for this purpose, computer aided decision-making with regard to the most complex problems confronting individuals and groups could prove to be of immense value. If accomplished, such systems could significantly enhance the quality of human decision-making without in any way depriving individuals of personal discretion, freedom of choice or values.

One such application would be the development of decision-making systems for helping men and women assess their mental, emotional, social and physical compatibility for successful lifelong partnership and also for navigating the complex subjective problems that arise in the course of human relationships.

B. Reuniting the Objective and Subjective

Efforts to develop a human science of accomplishment will bring us face to face with profound questions regarding the role of chance and causality as presently understood and programmed into the performance of physical systems. For the unquestioned premise of physical science is that in addition to the inflexible laws governing material nature, chance and uncertainty permeate every system. These factors are represented statistically by the concept of probability.

The social sciences have naturally adopted this premise as a universal principle governing all social and psychological outcomes as well. But the premise has never been put to the test of either scientific investigation or rational analysis. What social scientists commonly refer to as randomness, chance and uncertainty usually refers to conditions under which our knowledge of the conditions and factors determining and outcome is limited, not necessarily the inherent unpredictability of the events themselves. The biological evolutionary theory that creativity is the result of the interaction of random chance with fixed laws of nature is grossly inadequate to explain human thinking and creative processes.

This is especially true in the social sciences' approaches that largely ignore the influence of subjective psychological factors on outcomes because they are difficult to observe, evaluate and measure. Yet high achievers throughout history seem to possess an intuitive sense of these subjective factors that enable them to achieve a mastery over events of which others are incapable.

The relationship between objective and external factors in the social sciences is biased by the disposition of the natural sciences to regard all phenomenon as objective and physical in their origin and all subjective manifestations as derivative and dependent on physical factors. But a significant body of research and historical testimony support the opposite conclusion that at least with regard to human affairs the subjective takes precedent over the objective and the direction of causality is at least partially reversed. Here too, leadership in cognitive computing may help us explore one of the final frontiers of consciousness in its gradual emergence from physical unconsciousness in matter, subconsciousness in lower forms of life, and partial mental consciousness in human beings.

C. Thinking, Logic and Rationality

The remarkable achievements of Cognitive Computing in mimicking or excelling some forms of intelligent human behavior can serve as a valuable impetus for the further development of our understanding of the nature of the human mind, logic, rationality and ways of knowing. Present conceptions are all based on underlying premises founded on the natural sciences which are rarely even discussed.

One such is the nature of logic and what constitutes a logical argument. These are fundamental to our understanding of the world we live in. An object or person can be in only one place at a time. You cannot have your cake and eat it too. But they are not fully true. With regard to physical things, they do appear to hold true in most instances. But we now know that subatomic particles can behave as though they are in more than one place at a time or are spread out over an extended area or are not even actually objects at all, except to our way of understanding [9]. And when it comes to non-physical aspects of reality which are as real and even more important to our humanity – love, joy, knowledge, truth – the ordinary logic of the physical world seems to break down. Data is enriched when it is exchanged. Love and joy shared grow by giving. Knowledge given to others multiplies by the act of transmission, as every teacher can confirm from their own experience: learning by teaching. The limitations of our concepts arise from the fact that our thinking even in the social and psychological sciences is based on materialistic conceptions of logical validity that are often characteristic of the physical plane, but are far less useful when applied to higher orders of reality. Even with regard to physical reality, the capacity to detach from the apparent evidence of the senses, is an essential requirement for higher reasoning. Sense-based reasoning is a mixed variety limited by the available data. Pure reason is able to pierce beyond appearances, as Copernicus did when he conceded that the movement of the Sun relative to a stationary earth may not accurately represent the actual movement that is taking place.

Moreover, the common application of systems to mimic mental processes often overlooks the difference between analytic, synthetic and integrative forms of thinking. Analytic thinking harnesses the capacity of the mind to divide reality into parts and subdivide those parts into smaller units in order to reduce the whole to the sum of its constituent properties. This is especially useful in discovering the differences between phenomena, as in the classification of the physical elements or the different phyla in the plant and animal kingdom. Its primary limitation is the tendency to regard these elements as independent entities, missing the relationships and interdependencies between them and the whole of which they are a part. Synthetic thinking utilizes the capacity of the mind to aggregate independent elements in order to construct a knowledge of the relationships between the parts and of the whole as a system, which is the basis for the remarkable strides in systems thinking since the early 20th century and its major impact on the development of computer technologies. Its primary limitation is the tendency of the thinking mind to construct linear mechanistic conceptions and models of reality which include all the parts and their interlinkages but cannot envision the organic whole of which they constitute a lower order reality. This is true even of neural networks which mimic the neural activity of the brain based on the implicit assumption of the identity between mind and brain.

Integrative thinking utilizes the capacity of the mind for holistic insight to perceive the whole as a living organism rather than merely a complex physical system. Here the capacity for linear, mechanistic thinking is insufficient, even when it is able to encompass multiple fields and dimensions at the same time. It is noteworthy that almost all important concepts related to civilization, culture and personal dimensions of humanity's social and psychological existence can only be fully understood through this faculty. Peace, health, harmony, society, family, personality, love, joy, knowledge, truth, self and being are a few examples of concepts that only fully lend themselves to comprehension and expression as integrated wholes. Efforts to analyze their elements or construct wholes out of their parts do not recapture the reality of the organic wholeness. Reducing all reality to its manifest physical components leads inevitably to the conclusion that a mud pie and plum pudding have greater reality than Beethoven's Ninth Symphony and Shakespeare's Hamlet.

Integrated thinking is often described as intuitive, in that the processes which support it are not visible to the conscious mind and we do not consciously stimulate them by mental effort. But we can still learn how to develop this higher faculty by shifting our exclusive reliance away from other forms of thinking. Experience confirms that suspension of normal mental activity is a means to creative originality [10].

According to the testimony of Karl Popper and that of a great many scientists and original thinkers, these intuitive perceptions are the source of great discoveries and new ideas. It is ironic that science concentrates almost exclusively on the process of validating these intuitive insights rather than striving to cultivate the type of thinking that gives rise to them. In this sense, the more cognitive computing can be used to replace the more mechanical, unidimensional aspects of our thinking, the more humanity will be free to develop its higher creative faculties that make us truly human.

REFERENCES

[1] M. Ford, Rise of the robots: technology and the threat of a jobless future. New York: Basic Books, 2015

[2] R. Kurzweil, The singularity is near: when humans transcend biology. London: Duckworth, 2016

[3] A.F. Leuchter et al., "Changes in brain function of depressed subjects. during treatment with placebo," Am J Psychiatry 2002;159:122–129

[4] H. I. Weisberg, Willful ignorance: The mismeasure of uncertainty, New Jersey, Wiley, 2014.

[5] Garry Jacobs, "The Need for a New Paradigm in Economics," Review of Keynesian Economics 3, no.1 (2015): 2-8.

[6] F. Harmon and G. Jacobs, Vital difference; unleashing the power of sustained corporate success, New York, AMACOM, 1985, p.78-79

[7] S. Englund, Napoleon: A political life, New York: Scribner, 2004, pp.104-5

[8] C. Sullenberger, Sully: My search for what really matters, New York: William Morrow, Aug 2016

[9] Michio Kaku, "Nobel Prize Awarded to Two Quantum Physicists," BigThink 10 October 2012

[10] G. Jacobs, "A brief history of mind and civilization," Cadmus Vol. 2 Issue 6, 2016 pp.71-110