Age of Man Machine Hybrids

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When Garry Kasparov, the world chess champion lost the chess match to Deep Blue, the IBM supercomputer in 1997, Time magazine had commented, "Luddites everywhere were on notice: here was a machine better than humankind's best at a game that depended as much on gut instinct as sheer calculation." A distraught Kasparov sighed and rubbed his face in disbelief before abruptly walking away, forfeiting the match.

That was the first time that a machine had beaten an expert at an intelligent game. Since then milestones have been breached at regular intervals. We are living in the era of Artificial Intelligence (AI) in which machines have been taught to think like humans and act. They still lack self-awareness, an essential attribute of human consciousness and cognition. Robots do not yet know that they are robots. But given the exponential growth of technology, it is only a matter of time before they will acquire self-awareness that rivals human intelligence.

Of course, the advent of such super-intelligent machines will take some time yet to happen. Human intelligence is essential for reasoning, planning, learning, communication (using the rules of natural language), perception, decision making, and ability to manipulate objects and perform complex tasks. AI today can handle only some of these tasks, such as visual perception, speech recognition, decision-making, and translation between languages, writing reports based on data analytics, etc., though the AI wave-front is being pushed over to include new areas of cognition almost on a daily basis. It is drawing increasingly from interdisciplinary areas spanning multiple aspects of human knowledge and cognition, like mathematics, logic, probabilistic and econometric methods, computer science, psychology, linguistics, philosophy, neuroscience, neural networks, probability theory and statistics, genetic algorithms and complex paradigms based on reverse engineering of the brain as well as other areas.

Today's computers have super memories, they can easily perform millions of calculations every second and perform consistently at peak levels combining peak skills for an almost indefinite length of time. They can recall billions of facts most accurately within a fraction of a second. Using these calculations, they can break up an object into its tiniest elements -pixels, lines, circles, triangles, squares - and describe each of these parts as mathematical equations. This is the way a machine tries to recognise patterns and identify objects. It can possibly identify a rose, but will have no idea about the 'rosiness' of roses. It cannot yet attribute any qualia to an object, something the human mind does effortlessly. Machines do not also understand the simplest of things about our physical world, let alone the subtle nuances of the working of human mind with all its complex web of emotions.

But as human knowledge migrates to the Web, their horizon would expand exponentially, though that alone would not endow them with consciousness. There are several problems that remain to be resolved before thinking of creating "conscious machines". For one thing, much of our our thoughts are

subconscious, the conscious realm actually constitute only a small part of our total cognition. Emotion is another vital area, without emotions, we would often find ourselves constrained to make judgments and decisions. The problem is, how do you create a robot with emotions and a value system? Emotions like fear, anger, distress etc. helped human evolution, but which emotions will help robotic evolution?

Paul Davies uses the term "Designated Intelligence" (DI) instead of Artificial Intelligence (AI): "Designed intelligence will increasingly rely on synthetic biology and organic fabrication, in which neural circuitry will be grown from genetically modified cells and spontaneously self-assemble into networks of functional modules……Unlike in the case of human brains, which are only loosely coupled via communication channels, DI systems will be directly and comprehensively coupled, abolishing any concept of individual "selves" and raising the level of cognitive activity ("thinking") to unprecedented heights." That will allow humans someday to modify their brains and bodies, augment their human intelligence in ways not conceivable today and achieve a superhuman intelligence.[1] In course of time, collective super-intelligence and an ecosystem of ideas to control that intelligence for benevolent purposes would evolve.

Whether it would be intelligent design or Darwinian evolution of robotic intelligence is a question which is still open-ended. Just as our intelligence was not designed by an omnipotent creator but it had evolved gradually, it is not necessary that we have to design the intelligence of machines we create and teach them how to think; in all probability they may not think like us, but 'think' nevertheless. As Quentin Hardy of the University of California at Berkeley says in his essay "The Beasts of AI Island", intelligence is merely a toolbox we use to reach a given goal, which doesn't entail motives and goals by itself. The new "Age of Thinking Machines" may even force us to fundamentally rethink and redesign our institutions of governance, allocation, and production which today are far from perfect.[2]

Never before in the history of humanity have we experienced technology changing the entire landscape of man-machine paradigm so swiftly and so profoundly. Revolutionary breakthroughs have been achieved in image recognition, data analysis, autonomous learning, and the construction of scalable systems. These have spawned applications that were unthinkable only a decade ago, giving birth to systems that display significant language skills, skills for manipulating objects, leaning and problem-solving abilities, factual and procedural knowledge and even some rudimentary imagination. AI is increasingly replacing human decision making in many areas of cognizance – routine administration, engineering and construction, design, data analytics, and even robotics and AI programming itself. Of course there is still a long way to replicate human intelligence, but it may usher in an era in which there will probably be no such thing as 'pure' human intelligence, because all humans will be a combination of biological and non-biological systems which will constitute integral parts of our physical bodies, vastly expanding and extending their capabilities. Humans and machines will merge together to create a human-machine civilisation. The initial impact will be highly disruptive and there will be ethical, socio-economical and other unsettling issues that will have to be addressed requiring a level of maturity humanity has not yet perfected. As Quentin says, "We're building new intelligent beings, but we're building them within ourselves. It's only artificial now because it's new. As it becomes dominant, it will simply become intelligence. The machines of AI

[1] Davies, Paul, "Designed Intelligence" in *What to Think about Machines that Think*, Ed. David Brockman, HarperCollins, Loc 922.

[2] Hardy, Quentin, "The Beasts of AI Island" in *What to Think about Machines that Think*, *Ibid*, Loc 2859.

Island are also what we fear may be ourselves within a few generations. And we hope those machine-driven people feel kinship with us, even down to our loneliness and distance from the world, which is also our wellspring of human creativity."[3]

Man and machine will then become one unified, hybrid entity. These entities will perhaps continue to evolve following Darwin's law of selection: through competition, combat, cooperation, survival, and reproduction. They will learn to think, emote and empathise in their own ways which might be different from our human thought processes, emotions and expressions of empathy. As the author Clifford Pickover says, "We'll share our thoughts and memories with them. We will become one. Our organs may fail and turn to dust, but our Elysian essences will survive. Computers, or computer/human hybrids, will surpass humans in every area, from art to mathematics to music to sheer intellect. In the future, when our minds merge with artificial agents and also integrate various electronic prostheses, for each of our own real lives we will create multiple simulated lives."[4]

In fact, the process of merger has already begun and is progressing as rapidly as the progress of AI. Silicon-based intelligence has already made inroads into our carbon-based intelligence. Through neuroprosthetics, we can even today incorporate AI in our own bodies. Tools is what made us human, and we all use technology to augment our cognitive processes in some way or the other; in that sense, a calculator or computer becomes an extension of our computational abilities, a telescope or a microscope becomes an extension of our eyes, and an automobile becomes an extension of our legs. Now we have started integrating these tools into our bodies to create a more complex entity. There is a term for it: 'cyborg', (short for "**cyb**ernetic **org**anism"), someone with both organic and bio-mechatronic body parts.

The idea was certainly not new and has been used in literature, science fiction and movies since ages, and it does not even strike as unnatural or unusual when we see somebody with an intraocular lens, or an artificial cardiac pacemaker or Implantable Cardioverter-Defibrillator (ICD) which can deliver electrical stimuli to the heart to prompt the heart to beat at a normal rate. Thousands of people who have lost their hearing today can hear, thanks to their cochlear (inner-ear) implants; the auditory nerve reorganizes itself to correctly interpret the multichannel signal from the implant. A deep-brain stimulation implant is often used to help Parkinson's patients. People who are completely blind are able to 'see' a rough image of objects when a tiny video camera is fixed in their eyeglasses which converts an image into digital signals which are then transmitted wirelessly to a chip placed in the person's retina, which actives retinal nerves and send messages via the optic nerve to occipital lobe, where visual signals are processed.[5]

These people are partly cyborgs, and there are other real-life cyborgs, individuals who have become part-human, part-machine out of their own free will, signalling an inspiring and yet uncertain future. Musician Neil Harbisson is the first officially recognized cyborg and co-founder of the Cyborg Foundation. Born with achromatopsia, or extreme colour-blindness that meant his world was onlye of black-and-white, he is now capable of experiencing colours beyond the scope of normal human perception. Harbisson is equipped

[3] *Ibid*.
[4] Pickover, Clifford, "We Will Become One" in *What to Think about Machines that Think*, *Ibid*, Loc 2947.
[5] Kaku, Michio, *The Future of Mind, Ibid*, 249.

with a specialized electronic eye, a cybernetic enhancement to his biological self, which renders perceived colours as sounds on a musical scale through vibrations in his skull. In other words, the device enables him to "hear" color. Through continued use, his brain has formed new neural pathways, allowing him to develop an advanced kind of perception.[6] "At the start, I had to memorize the names you give to each color and I had to memorize the notes, but after some time, all this information became a perception," Harbisson stated in a recent TED talk. "When I started to dream in color, I felt the software and my brain had united."[7] His antenna was included in his 2004 passport photograph confirming his cyborg status. In 2010, he, along with artist Moon Ribas, created the Cyborg Foundation to help humans become cyborgs.

Jesse Sullivan is a double amputee, having lost both his hands in an accident, but equipped with two bionic arms connected through a nerve-muscle graft, he can now control his new limb with his mind, feel hot, cold, and the amount of pressure his grip is applying. He can climb a ladder at his house to paint the wall and can even do something much more important - hug his grandchildren. He the first to have a thought-controlled artificial arm.[8]

After a pair of horrific accidents, Jens Naumann became blind in both eyes. In 2002, he became the first person in the world to receive an artificial vision system, thanks to an electronic eye connected directly to his visual cortex through brain implants. Unlike in Harbisson's case or with other cyborg implants which translate visual information into another sense such as sound or touch, Naumann actually "sees" the world, though roughly - he can only vaguely see lines and shapes. But technically his vision, bad though it is, has been restored.

Claudia Mitchell is the first woman to become a cyborg - she has a bionic limb similar to that of Jesse Sullivan, which is connected to her nervous system, allowing her to control it with her mind. Her robotic arm allows her an extraordinary range of motions for practically all mundane daily tasks from cooking to folding clothes. At 66, Fran Fulton was fully blind for about 10 years, having lost her sight from a degenerative eye disease. Last year she regained her sight, courtesy a system called the Argus II in which a pair of camera-equipped glasses were hooked up to electrodes implanted in her eyeball, which fed her brain visual information. [9]

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[6] Nelson, Bryan, "7 real-life human cyborgs", http://www.mnn.com/leaderboard/stories/7-real-life-human-cyborgs, April 25, 2013, accessed 03/05/2017.

[7] https://www.ted.com/talks/neil_harbisson_i_listen_to_color, accessed 05/05/2017.

[8] http://www.nbcnews.com/id/14790160/ns/health-health_care/t/double-amputee-uses-thought-controlled-arm/, accessed 05/05/2017.

[9] Eveleth, Rose, http://www.bbc.com/future/story/20140923-im-blind-but-i-have-bionic-eyes, accessed 05/05/2017.

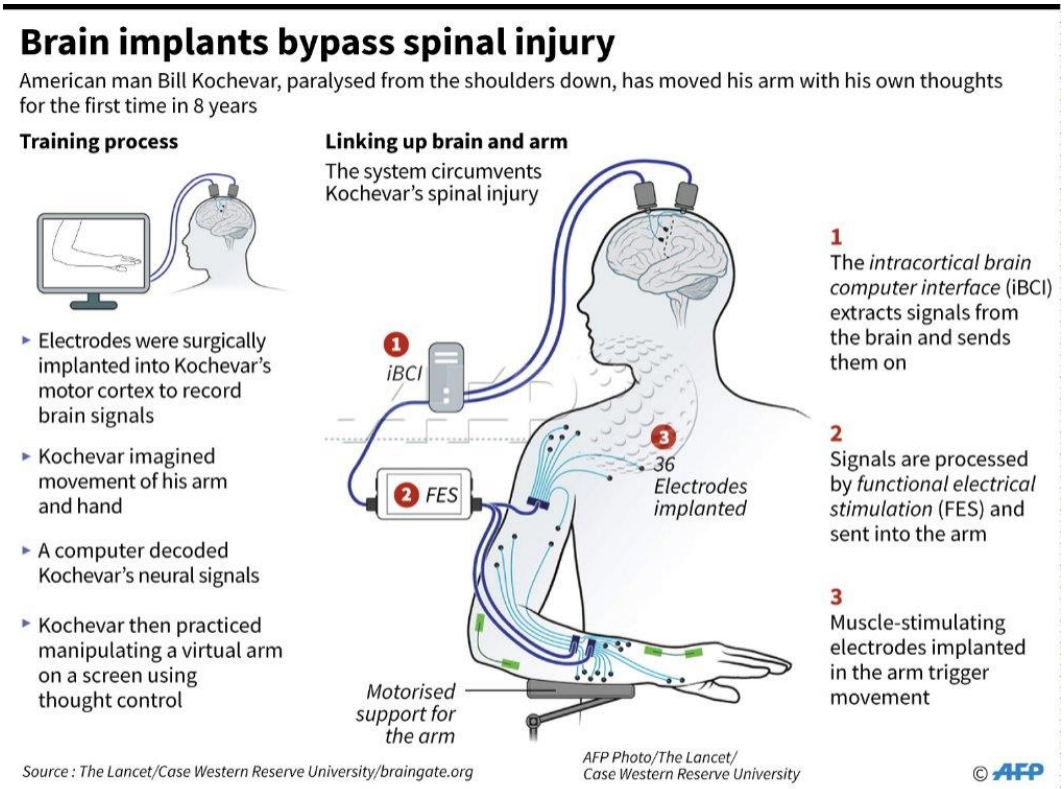
These are only a few of the numerous instances of living cyborgs, the so-called augmented humans. Augmentation is nothing new in human history - from his cave dwelling days when he had learnt to use tools to survive against huge odds, man has been an augmented being. The tools have only become smarter, and smaller – they have been constantly transforming the human condition and expanding the human potential. Given the diversity inherent in human nature, it is also imperative that there will be an explosion in the ways different people will like to augment themselves for diverse purposes, helped by emerging technologies which would 'create a future where a thousand augmented flowers will bloom'. Yet it is a myth that such augmentation will produce superhuman beings – augmentation isn't a "magic bullet" that will instantly endow every human being with incredible faculties to fulfil all his wishes; augmentation can only be a tool to help a man develop in new directions. It is also nothing unnatural.

The Future Man-Machine Hybrid?[10]

Augmentation is not the only way to expend the capabilities of the mind, there is also the brain-computer interface which can transcend the physical barriers through thought alone. Fifty six-year-old Bill Kochevar was almost completely paralysed from an accident eight years ago - he had no control over his entire body. In March 2017, scientists fitted electrodes to the part of his brain associated with motor movements which, in turn, were connected to a brain-computer interface and could interpret his thoughts and send messages to other electrodes designed to stimulate the muscles in his right arm and hand. As the science correspondent Ian Johnston reports, Kochevar is now able to "eat mashed potato with a fork or drink coffee simply by thinking about wanting to do it." His arm is still in a sling and its movement slow and awkward, but he can move it. It was the first time someone with complete paralysis had been able to grasp something and feed himself using a brain controlled implant in this manner.[11]

[10] Source: http://ichef.bbci.co.uk/wwfeatures/wm/live/1280_640/images/live/p0/27/b1/p027b1pn.jpg accessed 05/05/2017.

[11] http://www.independent.co.uk/news/science/paralysed-man-moves-arm-for-first-time-in-years-using-brain-implant-that-can-read-his-thoughts-a7654761.html, accessed 05/05/2017.



Brain-Computer Interface[12]

In another experiment that seemed straight out from science fiction rather than based on reality, using thought alone and the computer-brain link, a person in India was able to transmit greetings to people in France.[13] It was a brain-to-brain communication via the interface of the computer. As reported by Tanya Lewis, "Using noninvasive means, researchers made brain recordings of a person in India thinking the words "hola" and "ciao," and then decoded and emailed the messages to France, where a machine converted the words into brain stimulation in another person, who perceived the signals as flashes of light. From the sequence of flashes, the French recipient was able to successfully interpret the greeting." It was the equivalent of digital telepathy.

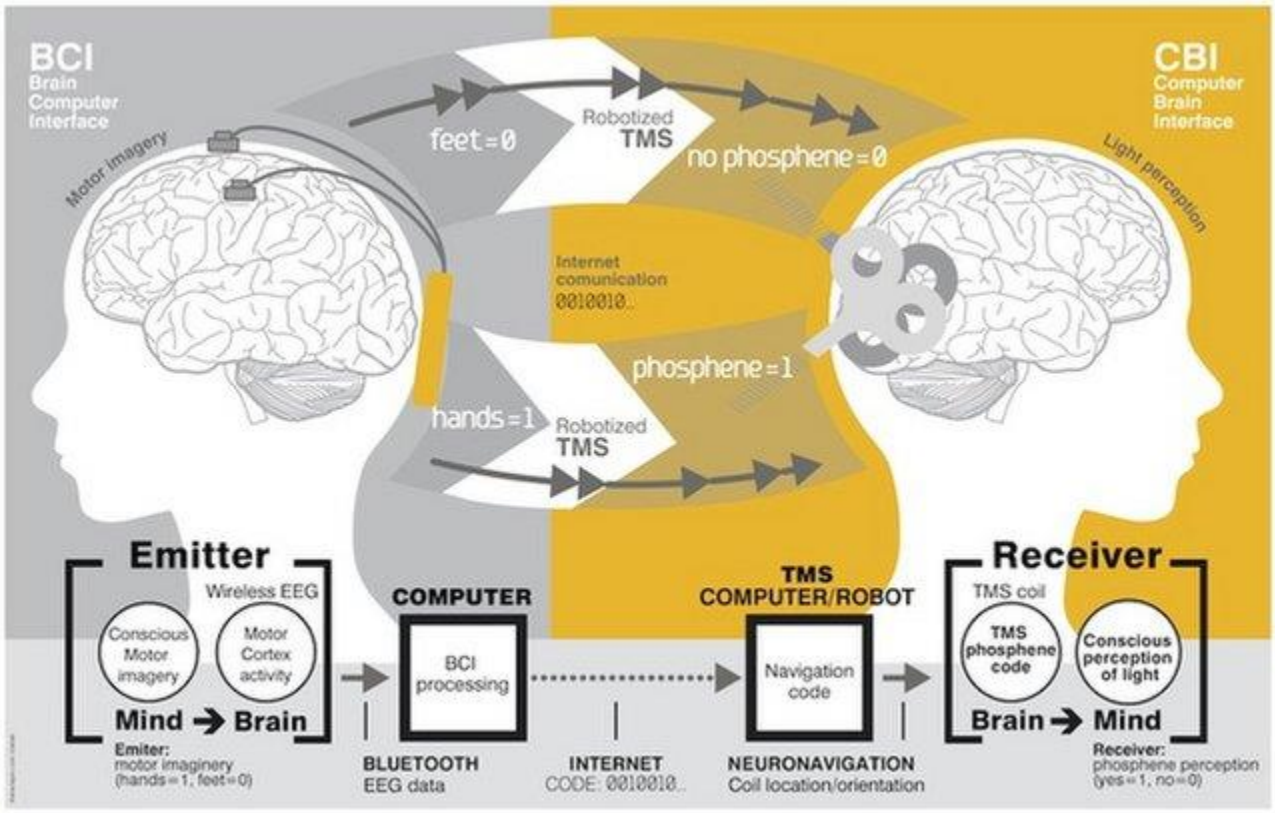
The technology is in its early stages, but it has very exciting potentials. It has the potential of decoding the thoughts of those who can't even blink.[14] Scientists have developed a brain-computer interface that can read the brain's blood oxygen levels and enable communication by deciphering the thoughts of patients who are paralysed, except for up and down eye movements, can only blink and are unable to talk, who are known as having locked-in syndrome. If all eye movements are lost, the condition is referred to as

[12] http://dunyanews.tv/en/Technology/381269-Quadriplegic-man-regains-use-of-arm-in-medical-fir, accessed 04/05/2017.

[13] Lewis, Tanya, "Mind Messaging: Thoughts Transmitted by Brain-to-Brain Link", September 5, 2014, http://www.livescience.com/47708-human-brain-link-sends-thoughts.html, accessed 05/05/2017.

[14] http://edition.cnn.com/2017/01/31/health/locked-in-als-brain-computer-study/

complete locked-in syndrome. They can hear, but cannot speak, they can be touched but cannot touch anything by themselves. In a trial of the system in four patients with complete locked-in syndrome - incapable of moving even their eyes to communicate - it helped them use their thought waves to respond "yes or no" to spoken questions. The non-invasive brain-computer interface could transform the lives of such patients, allowing them to express and convey thoughts feelings. It can help patients suffering from the debilitating motor neuron disease regain some control over their lives.



The researchers used electroencephalography (EEG) headsets which recorded electrical activity from neurons firing in the brain to convert the words 'hola' and 'ciao' into binary. In EEG, electrical currents in the brain are linked with different thoughts that are then fed into a computer interface. This computer analyses the signal and controls an action.

The brain-to-brain communication system[15]

Benefits of technology powered by AI and augmentation is indeed immense and their potential to transform the human condition is almost infinite. It is only up to us to decide how to leverage that potential to our best advantage, which is both our privilege and responsibility to ensure. In fact, by the late 2030s, as the 'futurologist' Kurzweil predicts, unaugmented, unenhanced humans may become a rarity. Reverse engineering may even make it possible to scan and upload the entire human brain onto a computer someday, not too far into the future. But a reconstructed, reverse-engineered brain would need a body to be put into, it could even be a surrogate robotic body playing host to a human - or a

[15] Source: http://www.livescience.com/47708-human-brain-link-sends-thoughts.html, accessed 05/05/2017 (credit: PLOS One).

human-machine - mind. As Kurzweil says, "Uploading a human brain means scanning all of its salient details and then reinstantiating those details into a suitably powerful computational substrate. This process would capture a person's entire personality, memory, skills, and history. If we are truly capturing a particular person's mental processes, then the reinstantiated mind will need a body, since so much of our thinking is directed toward physical needs and desires……. The human body version 2.0 will include virtual bodies in completely realistic virtual environments, nanotechnology-based physical bodies, and more."[16] Of course it is still in the realm of pure conjecture. It will make our minds if not our bodies truly immortal. Or the body could be frozen and preserved at cryogenic temperatures till we conquer ageing, disease and death when the body could be revived and the brain, that is the personality, uploaded into it. It might even be possible to gradually transfer our intelligence – with all our skills, learning, memory, emotion and consciousness – in fact our entire personality - to a non-biological form, leaving the mortal body behind like 'an aging shell'. May be the process has already begun unnoticed. To quote Kurzweil again, "We already have a variety of neural implants. In the 2020s we will use nanobots to begin augmenting our brains with non-biological intelligence, starting with the "routine" functions of sensory processing and memory, moving on to skill formation, pattern recognition, and logical analysis. By the 2030s the non-biological portion of our intelligence will predominate, and by the 2040s,…the non-biological portion will be billions of times more capable. Although we are likely to retain the biological portion for a period of time, it will become of increasingly little consequence. So we will have effectively uploaded ourselves, albeit gradually, never quite noticing the transfer."

There is a final question – can a machine be conscious in the sense that we understand the term? Actually consciousness is not a property possessed by an entity that can be measured; it is a combination of many elements spread across a continuum of experiences shared by all living entities, as well as and non-living things or machines. Objective measurement tools of science are inadequate to measure the subjective elements that constitute consciousness, at best they can measure the correlates of consciousness like behaviour or emotional expressions. Machines even today exhibit some of these behavioural correlates that point to elements that fits very well into the spectrum that consciousness is. But we must not forget that the future humans will not be distinct from machines, it will not be a question of 'us' or 'them'. Humans and machines will merge to constitute a unified entity where the distinction between man and machines will be obliterated. The question itself whether machines can have consciousness will then become meaningless.

[16] Kurzweil, Ray, *The Singularity is Near: When Humans Transcend Biology*, 2005, Penguin USA.