

Convergence singularities: As man becomes machine and machine becomes man

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Abstract— Within the AI domain there is discussion on the singularity event, the situation where machines achieve a level of consciousness and intelligence equal to or exceeding that of humans. This paper explores different perspectives on such a singularity. The main contentions are that a) it is a moving target in that using technology man is also expanding human capabilities – as such it is a convergence than a one sided movement; b) it is not one singularity but an array of singularities representing multiple attributes of humans and; c) singularities should be considered in a wider system perspective that takes account of organizational structures, individual motivations and practicalities. This paper provides an Information Systems and autonomic systems perspective on a machine-man/man-machine singularity. The paper hopes to make contribution by extending the discourse on such singularities and raise some practical and philosophical questions for society and policy decision makers.

Keywords— man-machine singularity; convergence singularity

I. INTRODUCTION *HEADING 1*

The ‘singularity’ is the expected situation where artificial intelligence (AI) machines achieve a level of intelligence and consciousness equal to or exceeding that of humans. This concept has engaged many imaginations over many decades in both academic research and in popular science fiction literature and film (e.g. 2001 A Space Odyssey, I Robot, Terminator, Matrix). Indeed some of the main themes, concepts and implications of machine intelligence and consciousness outstripping humans are often explored in fiction and film better than in academic research: Academic research usually focuses on specifics of the ‘how to do’ elements of machine intelligence (such as new algorithms and technologies) whereas fiction explores wider sets of issues and takes forward particular ‘what if’ scenarios.

However, the research endeavours into AI have been phenomenal [18], possibly tying into some underlying human desires for technology and advancement [15]. In the early computing years the possibility of machines achieving human level intelligence started to become a possibility as technological advances took place, though considerable challenges we identified:

"In the future, if and when this degree of complexity is attained by a single computer, we shall perhaps be able to find out if it can be made to match the power of thought of the human brain.

The problem of programming such a super-computer will still remain, however. The limitations of man as a

programmer will always, in the end, set a limit to the intelligence that can be simulated by a machine. A computer's 'artificial intelligence' is prescribed by man, and a higher intelligence is demanded for the prescription than for the execution. Man, as the originator, will always be on top." [12]

Over the more recent decades considerable effort within the computer science domain has been focused on developing AI techniques and technologies many of which explore ways of surmounting the 'originator barrier', including Logic systems, Bayesian networks, Neural networks, Simulated annealing, Swarm Intelligence algorithms and many more [18]. At the same time as developments in AI the processing and storage power of computer systems have expanded at phenomenal rates over the decades providing a raw processing intelligence base for running such AI systems. Concurrently with these advancements, research into consciousness has also been fairly active drawing upon several fields including computer science, neuroscience, cognitive science, psychology, philosophy and others [5],[3]. Seemingly the foundations for developing machines that ‘think’ are well in place [14],[15] and that we are well on the way towards a singularity event.

A wakeup call to the imminent singularity was the chess match in May 1997 between the world chess champion Garry Kasparov and the Deep Blue chess-playing super computer developed by IBM. Deep Blue won a six-game match (two wins to one with three draws – though Kasparov claimed IBM cheated and asked for a rematch, which was refused by IBM who relatively quickly dismantled Deep Blue). In a very limited sense this was an example of a singularity event: a machine beat the best of humans in a complex thinking task – that of playing chess.

Issues and concerns over a singularity event have been gaining ground in the wider public and academic communities over the previous few years with emergence of specialist conferences, forums and workshops focusing on the possible singularity event. Possibly the most prominent of these being the singularity summit in the US, which aims to: "explore the rising impact of science and technology on society. The summit has been organized to further the understanding of a controversial idea – the Singularity scenario" (from <http://www.singularitysummit.com/>). Tied in with the summit is the Singularity Institute (see <http://singinst.org/>) which aims to raise awareness, engage in research and initiate public debate on the singularity event.

The singularity event is one of the big issues in future of computer science as well as the wider communities within society: A singularity event is likely to affect many stakeholders who may interact with and use such systems. Probably one of the strongest contenders for a route to machine consciousness is the development of sophisticated autonomic computer systems [2]. Such autonomic systems have to operate in real time in dynamic environments without human intervention. This paper explores an Information Systems (IS) and autonomic perspective on such singularities. The paper tries to extend existing singularity discourse along three main themes:-

a) The singularity is a moving target in that the capabilities of man are also expanding, both in evolutionary sense and also in the adaptation and employment of drugs and technologies. Consequently the singularity it is more a convergence than a one sided movement. Man's capabilities are being extended moving towards capabilities found in a range of technologies and machines (this we refer to as man-machine) while machines are moving towards man's capabilities, such as empathy and consciousness (this we refer to as machine-man).

b) It is not one singularity but an array of singularities representing multiple attributes of humans and of autonomic system machines. For instance, human attributes cover socializing, empathy, creativity (and other) capabilities as well as intelligence and consciousness capabilities. Different as well as overlapping sets of attributes are likely to emerge from the development of sophisticated autonomic systems.

c) Singularities should be considered in a wider organizational and system perspective that takes account of forces of change, organizational structures, individual motivations, economics, information flows and needs, practicalities and many other attributes affecting the success of a technology. Any likely future sophisticated autonomic systems that evolve into some form of consciousness will not operate in a vacuum: such autonomic systems are likely to interact with other entities (human and/or machine) and there is likely to be some economic, business, social or other imperative driving such interaction.

As such, this paper extends the discourse on man-machine singularity than found within the existing literature by combining an IS and autonomic systems perspective. The paper argues that such perspective is needed to make sense of the issues and implications of heading towards man-machine/machine-man convergence singularities.

II. A MOVING TARGET: MAN TO MACHINE AND MACHINE TO MAN

This section examines the convergence of extending capabilities – those of the expanding capabilities of man (man-machine) and those of intelligent machines (machine-man). The concept of singularity becomes non static; indeed it may even be asymptotic if the capabilities of man subsume the capabilities of machine intelligence. First we will

examine the man-machine activity then the machine-man activity.

A. Man to machine (Man-machine)

Man has also used tools and technology to improve and extend human capabilities, indeed tool making is one of the main attributes of man that distinguishes us from other animals and beings [4],[16],[9]. For instance, the use of throwing sticks and bow and arrows have been used to extend human capabilities in throwing weapons.

Much of the use of technology has been to address weaknesses or the loss of capabilities such as when people grow old. For instance glasses and hearing aids (hearing trumpets to digital hearing aids) have been used to improve sight and hearing capabilities - to bring them back to a 'normal' level for people. The support routes of technology development for people with medical conditions or disabilities often provide a base to improve human capabilities. Wheel chairs used to help people that can't walk enable wheel chair users to go faster than the normal walking pace or running pace of people that can walk (e.g. a 70 year old can trundle along at 8 mph in their electric wheel chair - far faster than a normal 70 year old can go without technology aid; a wheel chair marathon runner can often go faster than a normal marathon runner).

There is a wide range of areas where technology has been used to enhance human capabilities. Man has used telescopes or microscopes to increase sight capabilities well beyond normal levels. Hearing or sensing of sound has been extended from very low frequencies through to high frequencies heard by bat. One could even include sensing all the way up through the spectrums extending perception through higher and higher frequencies to light and X-rays. Cars, boats, submarines, trains, airplanes and spaceships have extended human capability to move around enabling humans to travel faster, carry bigger loads and travel through more environments than the human body can alone.

The man-machine mix can be classified into non-invasive and invasive. The non-invasive mix of technology with humans has been taking place for centuries, and would include all the traditional use of tools and technologies (e.g. hand tools, cars, production machinery). The non-invasive mix of technology would also include ICT, computing technologies and the Internet. These enable humans to communicate with each other almost instantly from around the globe as well as provide access to massive amounts of information. This also comes with sophisticated searching and processing capabilities which combined enables a potential step leap in cognitive capabilities providing understanding of and interaction with the environment from the micro to the macro level.

The non-invasive extension of human capabilities, the man-technology mix, provides the base for a closer interaction between man and technology - the invasive

extensions (i.e. once a technology has been produced it can be applied closer to the body functioning). For instance, invasive heart pace-makers bring normal heart functioning to people with heart conditions. External hearing aids can be replaced with ear implants and so providing a more robust, finely tuned and less obvious support for people with hearing difficulties, as well as addressing hearing problems that cannot be addressed by an external hearing aid. Artificial limbs can be used to enable leg amputees to walk again. Much invasive use of technology has been to address deficiencies and weaknesses in people, but they can also be used to extend capabilities beyond the normal. It is only a small step to improve ear implants to be able to provide extended hearing range well beyond the normal levels. Paralympics runners can use carbon fiber limbs to run faster than normal runners.

This is the realm of the 'six million dollar man' and other science fiction. However, the reality has caught up with many of the themes in fiction. In David Rorvik's [17] 1970's book, 'As man becomes machine', the concepts of integrating machinery and computers with human biological functioning are well discussed, based on the current science and research of the time. Though Rorvik's book seems a little dated now, the concepts of Electronic Stimulation of the Brain (ESB) and Bio-feedback Training (BFT) show the possibilities of closer interaction between people and technology.

More recently, the work by Professor Kevin Warwick, at Reading University's Department of Cybernetics provides an up to date indication of where such technology is going. Professor Warwick – classed as the first cyborg – experiments in the late 1990's involved implanting a microchip into the nervous system into his arm and used it for direct communication with a computer to control simple machinery, like switching on and off a light. These pioneering experiments involving the neuro-surgical implantation of a device that can directly interact with the median nerves of his left arm allowed a direct link between his nervous system and a computer. A follow on set of experiments involved having a similar device connected up to his wife then to communicate directly from one person to another directly via the nervous systems.

Interaction and control directly from human nervous system is now a reality. From past technological development it seems that the military and intelligence communities are usually at the forefront of using 'useful' technology, possibly using the technology 5 to 10 years before it gets to the general public. 'Useful' technology in a military context can include anything that could have a possible military purpose. For instance, it may be very desirable for generals to be able to locate and communicate with each troop on the ground, and to be able to receive high definition reconnaissance data from each of those troops. It would be advantageous for troops on the battlefield to be able to get better information on where their colleagues are, the terrain and obstacles around them and of course

information about where the enemy is. Equally, it is easy to see where it would be desirable to have location, health and 'condition' information on troops particularly when it comes to casualties. Much of the future of man-machine enhancements may already be here.

B. Machine to man (Machine-man) Machine Consciousness and Autonomic Systems

Two aspects of machine-man will be explored here, one focusing on autonomic computer systems and the other on machine consciousness. One of the main sets of trends in computer systems has been towards more powerful and more sophisticated machines that undertake more functionality. The result of this has been computer systems that have to deal with more autonomy, increasing functionality and consequently increases in operating uncertainties and inconsistencies. This is the realm of autonomic computer systems. Ganek and Corbi [10], in their much quoted paper discussing the 'dawning of the autonomic computing era' describe the main attributes of autonomic computing systems as being self managing systems with self-configuring, self-healing, self-optimizing and self-protecting capabilities. Ganek and Corbi's view of autonomic systems come from a business systems perspective, such as large network operating systems within complex and dynamic environments. However, autonomic computer systems derive their name from biology based on autonomic nervous systems (also known as involuntary nervous systems) within the human body, and are essentially the regulatory mechanisms of digestion, respiration, circulation of the blood etc. Although biology autonomic systems cover mostly involuntary functions, such as heart rate, these can be brought under some voluntary control (for instance, conditioning and meditation to control heart rate). There is much debate within medical and biology spheres on the relationship between the apparent voluntary and involuntary control mechanisms within the body: "The fact that much behaviour is involuntary and conscious raises such questions as: Why is some behaviour voluntary, and under conscious control? It seems that high rates of information-processing in unusual situations require consciousness, and are voluntary" [11, p66].

As a set of body operating functions becomes well defined with interrelated feedback systems, then this set of functions can operate within some autonomic control system [2]. Within that autonomic control system there are involuntary controls operating almost independently of the voluntary controls. However, as the amount of information and processing increases for functions, and variety in operating situations increase, then this requires more voluntary control mechanisms. Applying this biology analogy to computing autonomic systems it seems likely that some form of 'voluntary' control will be required as the amount of information and variety in operating situations increases. Machine-man capabilities can be extended by taking an autonomic approach, using a mix of voluntary and involuntary functionality, with the voluntary capabilities

operating at a higher abstract level. This is getting closer to thinking [15] – a very human attribute.

Closely related to this concept of machines thinking is machine consciousness. Of course consciousness is a complex phenomenon that occupies much debate within the sciences and philosophy. Susan Blackmore's [5] work collates together conversations from some of the leading philosophers, computer scientists and neuroscientists on what constitutes consciousness, along with the possibility of generating consciousness in machines.

As Aleksander [3] "the strategy for designing conscious machines is tough but, in the end, doable. It is founded on unraveling the undoubtedly complex functioning of the brain and transferring this understanding into computational machinery." (p13) and defines his own personal five tests, or axioms, for being conscious (i.e. to distinguish between appearing to be conscious and being conscious):

"The five axioms, the five different kinds of thought which are important to me and I feel need distinguishing are the following:

- 1) I feel that I am part of, but separate from an 'out there' world.
- 2) I feel that my perception of the world mingles with feelings of past experience.
- 3) My experience of the world is selective and purposeful.
- 4) I am thinking ahead all the time in trying to decide what to do next.
- 5) I have feelings, emotions and moods that determine what I do." [3,p34]

Aleksander brings out a common theme in discourse on machine consciousness that of consciousness equates to human consciousness. However, as with the discussion on autonomic systems above, perceptions within an environment must be based on the range and level of sensory inputs about that environment and the characteristics of the environment itself. Different environments and different sensory inputs may well result in different types of consciousness. Consider different animals, sharks (and other fish), dolphins, birds, bats, dogs – these all have different environments and different senses and sensory inputs to what people have. Any consciousness of these beings (if indeed they can be classed as being conscious – a philosophical topic that engages researchers in this area, but for this paper assume that they are conscious) would be different to human consciousness. Similar reasoning would apply to a machine-man consciousness being the product of a different set of sensory inputs from a similar by likely different environment (say a more electronic environment). Humans from their blinkered human perspective have an understanding of what consciousness means for them; other intelligent and conscious being (if they exist) may well have their own (and possibly equally blinkered) perspective of what consciousness means for them.

III. MULTIPLE SINGULARITIES

One of the contentions in this paper is that there is not one singularity but an array of singularities representing multiple attributes of humans and human intelligence. For instance, human beings have evolved over many years (millions of years) to be able to explore, sense, perceive, learn about, move within, interact and shape their environment. They have evolved an imagination capable of creating many forms of art and complex imaginary worlds and contexts in stories and film. They have also evolved to be very sophisticated social entities developing many different social structures from small family groups to formal and informal structures to enable multiple millions of people to live together in the same city or country. They have evolved other social structures to enable production and distribution of food, products and services (such as markets, money and bartering systems). They have evolved and developed many forms of communication and languages. They have also evolved to be very adaptive and innovative able to populate most areas of the planet (and even off the planet), and develop many different types of tools and technologies. Perhaps one of the most significant elements of human attributes, or higher order of human intelligence and consciousness, is the ability to be humane, to have empathy to others (of the same and other species) and the environment. This is moving from self awareness to self responsible.

Humans are temporally rich in skills, they can interpret and make sense of past events and look forward and make fairly accurate best guess predictions on future events (for instance predicting what another person or animal might do in a situation, or predict the weather or the next eclipse). People are quite good at learning and passing this learning on to other people. Even organized groups of people, say at an organizational level are able to learn. Humans are able to learn about learning and deal with multiple constructs both abstract and 'real' [8].

Each of these rich dimensions of humanness and human intelligence provide a dimension with which potential singularities can emerge. The man-machine/machine-man singularities should really be considered as a convergence and synergy of capabilities mixing man and machine attributes that best fits a particular context.

IV. ORGANIZATIONAL AND SYSTEM PERSPECTIVE OF SINGULARITIES

A further contention of the paper is that the technological (and human) evolution towards singularity events should be considered in a wider organizational and system perspective. Technology impacts people, organizations and society. There are many forces and influences impacting the development and adoption of new technology and new systems. Man-machine/machine-man singularities represent new states of technology development and understanding of that

development requires some understanding of the underlying forces of change, the resulting impact on organizational structures, individual motivations and general practicalities. This is the realm of Information Systems.

New technological change impacts a range of stakeholders, organizations, working practices and social interaction – which can stimulate further technological change. For instance, Damsgaard and Gao [7] examining the evolutionary innovation of the mobile telecommunications market, describe the process as an ‘innovation circle’ where the introduction of a new technology stimulates further innovations in the mobile market place. Similarly [1] takes a similar approach that includes the user in the innovation process and refers to this as the problem-solution space or innovation-space. In a dynamic environment, when technology changes so too does user practices and needs. As user practices and needs evolve further opportunity emerges for technological led innovations. This dynamic environment, it is argued, consists of a changing problem-solution space which provides the ideal circumstances for innovation to germinate. When considering man-machine/machine-man singularities to this dynamic evolutionary development process, particularly in identifying the forces of change, the corresponding changes in working and social practices and the likely influences on further technological change.

A man-machine or machine-man entity would be resource intensive compared to say just a normal human (or machine). The extra resources of course would provide enhanced capabilities - enabling the entity to do more things, quicker, better or longer – but the resources consumed could be very significant. For instance the Garry Kasparov and Deep Blue chess match in 1997 involved a super computer, a team of programmers and computer engineers focusing on just that limited (but challenging) task. This raises issues of the economic case for development of technological man-machine/machine-man singularities. In what circumstances would such an enhanced entity be economically viable or sustainable? Would some man-machine/machine-man singularities be more economically, or practically viable than others, and if so then which ones?

Further, man-machine/machine-man singularities, than have to be considered in the context of the already existing inequalities in the world [19],[21],[6]: “About one sixth of the world’s population – mostly in the rich countries – are lucky enough to live in relative wealth, and the rest – mostly in developing countries – live in relative deprivation, if not desperate poverty” [22, pv]. As [20] identifies, on one level there is unprecedented opulence and on the other there is remarkable deprivation and destitution. The enhanced entity of man-machine/machine-man will likely raise specter of new type of underclass. The rationale and motivations towards developing man-machine/machine-man singularities have to be considered within the inequalities in the world.

Further questions and issues emerge around the development of such enhanced man-machine/machine-man entities and systems. For instance there is still the ‘originator barrier’ of AI systems, particularly in understanding the full workings and functionality of such an advance piece of technology. There will clearly be challenges in identifying the information and performance needs to develop a conscious intelligent system, but there will also be a further set of needs to consider of the actual conscious intelligent entity itself. With man-machine/machine-man singularities the number of stakeholders to be considered has been increased by (at least) one.

V. DISCUSSION AND CONCLUSION

This paper has tried to provide a more IS perspective on man-machine singularity than found within the existing computing literature. We argue this is important since an IS perspective is needed to make sense of the issues and implications of heading towards man-machine/machine-man convergence singularities. The discourse on the man-machine singularity has to move away from just the technology and philosophical questions: Questions also need to be raised on the practicalities of how such systems can be developed and applied and the corresponding impact on society, organizations and people. To help identify some of these important questions this paper has extended the man-machine singularities discourse by identifying: the singularity is a moving target (in that using technology is helping man expand human capabilities) so it is more a convergence or synergistic even; that the singularity is actually an array of different singularities representing the multiple attributes of what it means to be intelligent humans beings and; singularities should be considered in a wider system perspective than just the technological and academic – it should take account of the practicalities of introducing new technologies including the economic, organizational, social and individual impacts.

Considering these perspectives some key questions emerge including: How will society be organized with such enhanced beings? Would machine-man entities have the same status, roles, responsibilities (social, tax, voting rights) in society as man-machine entities, or normal people? What will be the legal implications of the evolution of machine-man entities and how will laws change to recognize this? Which man-machine/machine-man singularities are more likely than others? Which singularities have more economic or social benefit for society, or which will be most problematic. What will be the optimal or practical level of man-machine/machine-man entities within a population? Would it be one to one or one to ten? What criteria and metrics would make sense in identifying an optimal level? Which of the man-machine/machine-man singularities are likely to be problematic (for humans) and which are likely to offer benefits? These are likely to be key philosophical questions that will task computer scientists and many other people in the years to come.

Would raw intelligence measures, say processing or storage power, be more significant (on what ever scale) than say social intelligence, such as empathy or social capacity, or creative intelligence? If the human race in the future encounters other intelligent species, say in space travels, then would good or enhanced empathy, or innovative skills be more beneficial than raw intelligence?

Is there a natural synergy between man and machine (coming from either the man to machine or the machine to man route) that provides some form of optimal being or existence (however that can be measured or categorized)? Evolution theories suggests that successful entities will evolve to fulfill a niche within the wider environment – in which case what would a man-machine/machine-man niche be?

As many commentators on AI and machines consciousness identify, designing conscious machines is 'tough' calling for many breakthrough steps in computer science. Equally, as this paper has hoped to show, the route to practical and useful conscious machines has many 'tough' challenges outside of computer science and indeed many tough challenges across disciplines.

For many of the questions raised here we can draw upon key thinkers throughout history that have grappled with similar social and ethical dilemmas. Would the world become an autocracy directed by one single uncontrolled supreme man-machine/machine-man being? This is similar to Plato's ideas of a society ruled by an enlightened few – the enhanced man-machine/machine-man entities. Technology could play a role in enabling that to happen with the increased power of electronic monitoring systems and processing power to make massively informed decisions on how societies can be run. However, there is a strong argument that this would not happen. As machine-man systems became more autonomic and conscious then they are likely to adopt other human attributes, such as being individuals and valuing systems similar to those of humans. Also, democratic systems and market systems seem to have evolved to be an efficient mechanism for allocation of resources between many groups of people as well as providing the stimulus for technological advancement. At a basic level one could say they we are fundamentally human animals with human animal needs, such as food, shelter, reproduction, socialization etc. Are our fundamental human needs likely to be that different over time? Maslow developed the concept of a hierarchy of needs, sometimes represented as a triangle of needs with basic food and survival needs at the bottom, leading up to self-actualization at the pinnacle. Is life, the fundamentals that is, likely to be that much different today than several decades ago when Maslow first introduced it? As machine advancement continues to mimic human capabilities then they may have their own hierarchy of needs, some of which may be similar to humans. Indeed, the more closely the machine-man/man-machine entities become then the closer the hierarchies of needs will become. They will be motivated by similar things

and value similar things. But it is up to society in how the direction of technology unfolds. However the man-machine/machine-man singularities emerge and evolve the arguments covered in this paper indicate that this will be a rich area for future IS research.

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