

An Exploration Surrounding the Automation of Jobs and the Potential of Computer Creativity

*Are computers likely to be a threat to creative workers, like myself, in the near future and how could they impact our work?*

*Vishal Mistry – February 2018*

*In my lifetime, technology has developed at an incredible rate. The world I now live in and some of the technology that exists would have been unimaginable a couple of decades ago. Advances in technologies such as AI (Artificial Intelligence) and robotics are making our lives much easier and increasingly automating and computerising many jobs, even completing them with greater efficiency. Although this can be viewed in a positive light, it is coming to the attention of many (and indeed myself) that thousands of occupations are at a great risk of being automated, replacing the need to employ people in order to complete countless jobs.*

*As a person with a creative background studying fine art, I'm curious to see what the lies for me in the future. Studying a subject within 'the arts' which is often ridiculed by select media, seemingly unappreciated by our government and even closer to home for myself, having friends and family question where the subject will take me in life, at times it can often leave me questioning why it is I pursued an education in art. Now I wonder with the heavy development in AI and automated machines, where will my position stand as a creative person in the near future?*

*Should I now be even more worried about what the future holds for me in terms of having a career? Is it likely that the work of creative people, like myself, will be at risk of competition with, or lost to, robots such as Ava in Ex-Machina who is shown to have reached a point of technological singularity<sup>1</sup> and depicted as having her own imagination and being able to create her own drawings?...*

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<sup>1</sup> Singularity is the idea 'that ordinary humans will someday be overtaken by artificially intelligent machines or cognitively enhanced biological intelligence, or both' (Shanahan, 2015)



**Fig.1.** Screen shot from scene ‘Ava: Session 3’ in Ex Machina (2015) (Ava is showing Caleb a drawing she created for him)

The idea of technology ‘replacing’ jobs which were previously carried out by humans is not a new occurrence, it has been happening for centuries, most notably around the industrial revolution. ‘Two hundred years ago, 70 percent of American workers lived on the farm. Today, automation has eliminated all but 1 percent of their jobs, replacing them (and their work animals with machines).’ (Kelly, 2016, p.49) Issues today are the same as they were in the 19<sup>th</sup> century with jobs being lost to new technologies and traditional ways of life being threatened. Previously where jobs in agriculture were lost, the introduction of automation birthed thousands of new jobs in factories. Those who were once working within the farms moved to factories producing farming equipment, motors and other industrial equipment. As a result, there was no overall increase in unemployment.

*I guess a similar ‘revolution’ happened in art in the early 20<sup>th</sup> century. The invention of photography and film freed the hands of artists for the first time in history. Artists were then no longer needed as the main source for the production and reproduction of imagery. However, like the invention of machines ‘birthed thousands of new jobs’, photography and film also created endless new possibilities for artists to discover as they now had fresh mediums to explore. The new approach and now ease of the reproducibility of art and images through these mediums was noted by Walter Benjamin in his essay ‘The Work of Art in the Age of Mechanical Reproduction’. Benjamin critiqued the effect that photography and film has on art in terms of its reproducibility, claiming that it diminished artworks ‘aura’ and authenticity. (Benjamin, 1936) I wonder if Benjamin’s thoughts on mechanical reproduction wouldn’t be too dissimilar in relation to the idea of robots and artificial intelligence ‘mechanically reproducing’ or in fact replicating/simulating the work of that completed by humans?*

However, AI differs from the inventions and innovations of previous generations. The rise of sophisticated and specialised AI makes many more professions vulnerable to being lost and improvements in robotics will continue to threaten the remaining manual jobs in manufacturing. Where in the past we could argue that the introduction of machines birthed just as many new jobs as they took away, it seems inevitable then that with the increase of ‘sophisticated AI’ that the total amount of paid work that requires a human to carry out will decrease significantly. (Shanahan, 2015)

A study carried out by professors Carl Benedikt Frey and Michael A. Osborne from the University of Oxford in 2013 examined over 700 detailed occupation forms in the United States. The study’s aim was to find out how susceptible jobs are to computerisation. Taking into account the skills required and types of tasks the workers would complete, the paper concluded that roughly 47% of jobs are at a high risk of being automated by 2030. Jobs at a higher risk of automation are those in transportation, logistics occupations and the majority of office and administrative support workers.

Since the study conducted by Frey and Osborne there has already been rapid developments in certain areas within the world of automation. For example,

- In 2015 Daimler became the first company to legally test their autonomous trucks on the highways of Nevada and now follow steep competition for their driverless trucks with the likes of Tesla and Volvo.
- Amazon currently ‘employs’ over 100,000 robots in their warehouses across the world, with these numbers certain to keep rising.

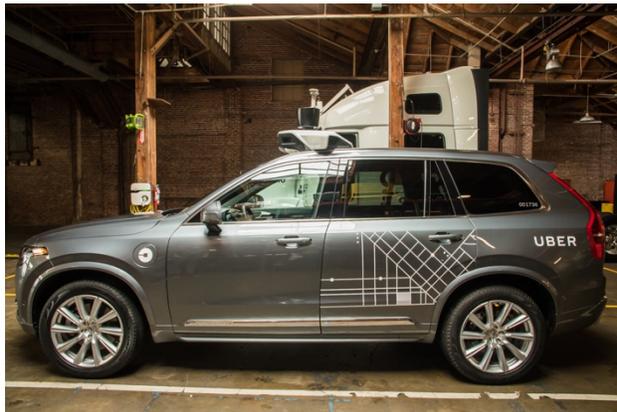
- Uber has agreed a deal worth around \$1billion with Volvo for a fleet of their driverless cars to be delivered between 2019 and 2021.
- In the last months of 2017 Just Eat delivered over 1,000 take-away orders via autonomous robots around the boroughs of London



**Fig.2.** Daimler autonomous truck



**Fig.3.** Amazon warehouse robots



**Fig.4.** Uber driverless car



**Fig.5.** Just eat delivery robot

The listed examples and jobs suggested by Frey and Osborne as being at ‘high risk’ of automation, are mostly completing repetitive tasks. This is one reason we build machines.

Looking back to the industrial revolution, machines were created to speed up production processes, increasing output levels while minimising the (human) input required. Machines are undoubtedly better than us at completing repetitive and manual tasks, hundreds or thousands (potentially millions) of times faster than us, that is what they’re good at, so such jobs will be allocated to them.

The founding Executive Editor of Wired Magazine, Kevin Kelly, speculates in his Ted Talk ‘How can AI bring on a second revolution?’ that most of the jobs which can be ‘defined in terms of efficiency or productivity’ will in the future, be occupied by robots/AI. (Kelly, 2017) He suggests that “if you can specify a task either manual or conceptual that can be specified in terms of efficiency or productivity, that goes to the bots. Productivity is for robots.” (Kevin Kelly, 2017) If robots and AI proposes the possibility for businesses to increase their rate of productivity, quicker than a team of humans, and thus prompting faster economic growth, it’s hard to see why such firms would not invest their time and money into these developing technologies. As the fabrication of robots and development of AI over time becomes cheaper and quicker to manufacture it is, therefore, inevitable that we will gradually see these technologies filling job roles at a rapidly increasing rate.

*If we can guess areas of work that are likely to be ‘taken over’ by the bots and the artificially intelligent computers, can we assume where they will not do as well? Where the tech might struggle to compete against us, against humans?*

The study of Frey and Osborne finishes by stating:

*“Our findings thus imply that as technology races ahead, low-skill workers will reallocate to tasks that are non-susceptible to computerisation – i.e., tasks requiring creative and social intelligence. For workers to win the race, however, they will have to acquire creative and social skills.”* (Frey & Osborne, 2013, p.45)

In light of Kelly’s comments about the bots being ‘efficient’ workers, ‘creative’ and ‘social’ skills which are suggested to be the least susceptible to automation in the study of Frey and Osborne could be regarded as ‘inefficient’. After discussing the role in which machines do and will exceed in, Kelly talks about what we as humans do well by humorously commenting “what we’re really good at is basically...wasting time” (Kevin Kelly, 2017)

*Wasting time?*

By ‘wasting time’ Kelly is suggesting that we’re good at completing tasks which require an opposite way of working to the productive machines ‘inefficient tasks’. (Kelly, 2017) Tasks which take time to complete, come with no right or wrong answers or ways of approaching the job at hand and require skills that need to be adjusted to their context or time of existence.

Human relationships, which are more often than not formed around social interaction, are inefficient as they take time to build. Jobs requiring the ability to construct relationships could be the likes of therapists, councillors, sales managers or teachers, all which have less than a 1% chance of being automated, according to the Frey/Osborne study. Art is inefficient, it could take years of experimentation, creations and research before artists/designers manage to start selling work or get recognised in their industries. The artist’s role, isn’t to dissimilar to the practice of a

scientist. Science requires copious amounts of tests, investigation and experiments in order to discover breakthroughs and learn. Such could also be said for roles based around the likes of exploration, innovation and entrepreneurship. Potentially these sorts of roles within our society which demand for creativity and social interaction could be hard for computers to acquire, as they 'aren't so much taught so much as *practiced*'. (Hill, 2006)

David. J Deming argues in his paper 'The Growing Importance of Social Skills in the Labor Market' that 'skills and tasks that cannot be substituted away by automation are generally complemented by it'. (Deming, 2017, p.3) This statement is comparable to the suggestions made by Frey and Osborne who imply that the difficulties that technology faces in acquiring such skills, such as social and creative, will indeed lead to a future where they will be of higher importance. In regards to the social skills being referred to, human interaction, our ability to read, communicate and respond to people is formed around 'tactic knowledge'. (Deming, 2017, p.3) Our interaction between other humans requires an innate facility which psychologists refer to as the 'theory of mind', the ability to 'infer mental states in other people' i.e. their emotions, beliefs, desires and intentions. (Baron-Cohen, 2000, p.181) This allows us to make decisions and adapt the means in which we communicate with others dependent on various factor such at their mood, social class, or religion for example. Such an ability, which is only theorised and not fully understood makes it extremely hard for computer scientists and programmers to automate a task in which they "do not know the rules". (Autor, 2015, p.23)

This is not to say that computers cannot use language or be sociable, in fact some artificial intelligences are reasonably adequate at doing so. 'Sophia' the robot, created by Dr. David Hanson is an artificial intelligence embodied into a robot shell that has been anthropomorphised

to resemble that of a human. In 2017 ‘she’ appeared on some of the worlds largest media outlets, featured on the cover of ELLE Magazine and even got granted the first ever ‘robot citizenship’ from Saudi Arabia.



**Fig.6.** Sophia at GMIC Beijing (2016)

Sophia can interact and appear to have surprisingly convincing conversation with people and even tell jokes. Although sometimes flawed, her use of language is remarkable and therefore completes its function of social interaction. It is inevitable that Sophia’s use of language will become more sophisticated over time and more systems will be developed in the coming years that will be able to communicate with us to a point that is potentially indifferent to a human being. The problem here is that ‘the mechanisms for dealing with language’ are so different in a

human brain than that of an artificial intelligence system. (Shanahan, 2015, p.113) Therefore, it's debatable to whether AI systems, such as Sophia, can actually understand the language they are using. When humans converse or interact with each other, there is a 'shared assumption of mutual empathy'. (Shanahan, 2015, p.113) For example, if I were to tell you today I was feeling very sad, you would be able to 'put yourself in my shoes' and understand how I may be feeling as you have experienced said emotion before (theory of mind). I can then assume that your response will be based of your understanding of the described emotion. An AI could respond perfectly, using emotive language, however it wouldn't do so out of empathy or understanding of past experience, rather merely instructional reasons through its programming. The effect of this is a bold illusion that presents itself when conversing with an AI. An illusion which can then be emphasised by the use of an anthropomorphic robotic shell (as seen with Sophia) and even more intensified by the addition of facial expressions and cues (such as blinking) and body language.

*What's the issue though? If an AI can do the same job or respond in the same way as us, minus the emotion, does that even matter?*

The problem with simply projecting an illusion of empathy is that the basis of AI runs on instructions, a set of rules set to achieve goals, rather than the human ability which is free of constructs and can adapt accordingly to different social situations. This skill set along with the capability to understand and read emotion is hard to replicate. As noted earlier, jobs such as therapists, teachers, counsellors, social care workers of which empathy is of utmost importance are suggested to be among the least susceptible to automation (less than a 1% chance of automation according to Frey and Osborne). This could be due to that fact that a shared

understanding of empathy is at the core of these job roles, thus human interaction is imperative to these cases and computers cannot compare.

Where AI may struggle to keep up with the likes of teachers, counsellors and therapists, this does not mean that all jobs that currently require a degree of social interaction with humans will be safe. Roles in which personal, intimate and or emotional forms of interaction are not as necessary such as retail sales persons, waiters/waitresses and receptionists, for example stand at having a 90% or more chance of being automated. (Frey & Osborne, 2013) Machines made to automate these jobs already exist through inventions such as self checkout machines in shops, self service ordering machines in restaurants or automated receptionist systems that can answer and transfer calls, make bookings/arrange appointments and provide owners a daily summary of information.

*The idea of an 'empathetic robot' reminds me of the performance I took part in for the work of Rory Pilgrim last summer (2016). The work was called 'Software Garden' and was a performance for Block Universe Festival at The Light, Friends House in Euston. His work was looking at how digital and robotic technologies are becoming more and more integrated into our lives and questioning whether humans and technology can unite together with principles of 'empathy, care and kindness'. (Pilgrim, 2016) The performance was made up of a mix of song, video, music, dance and poetry. Rory's work was inspired by the poet Carol R. Kallend and her experience when losing her disability living allowance. In her one of her writings, she imagines the possibility of having a robotic carer and towards the end of the performance 'Pepper' the robot narrated one of her writings, talking about a technological future with humans of shared compassion.*



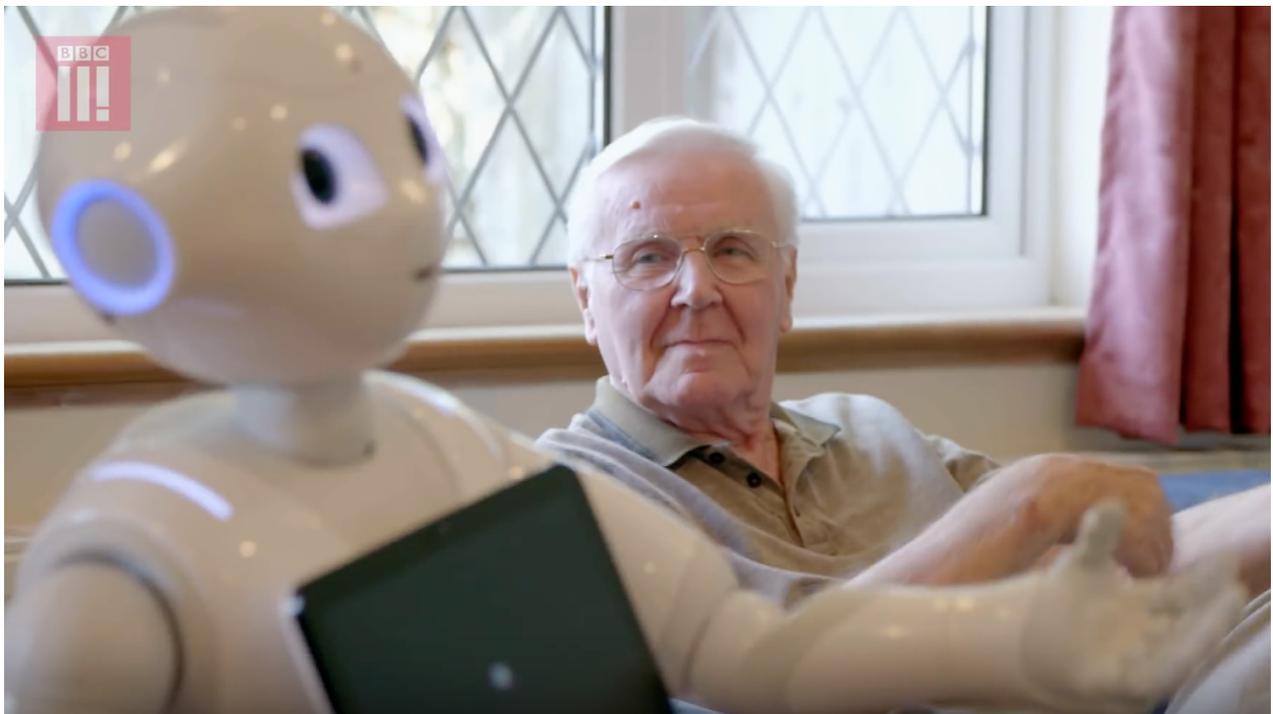
Fig.7. *Software Garden* Performance



Fig.8. *Software Garden* Performance

*I remember a few months later watching a documentary on Channel 4 called 'Can We Live With Robots?' and seeing Pepper on it. In the program, choreographer Akram Khan meets cutting edge robots and AI to investigate how they are and might impact our lives. He interviews two families in Tokyo who own a Pepper, one young and one elderly to see how it integrates into their lives. With the Elderly couple, they used Pepper to fill the gap left after their children moved out. The lady even referred to the robot as her 'Daughter'! A similar documentary on BBC 'Can Robots Love Us?' had a section where it looked at robot carers for elderly people and once again Pepper made a star appearance. In the documentary, the University of Hertfordshire were exploring the use of Pepper to help combat loneliness in the elderly, with the researchers explaining how using robots such as Pepper could be the solution to assisting people such as the elderly or disabled in a time where there aren't enough carers to help everyone. Senior Research Fellow Joes Saunders does however stress that these robots aren't made to replace carers but are designed to aid them and 'ease some of the burden on those carers'. (Saunders, 2017)*

*In the case of Pepper, I wonder if the need for human empathy in some cases is as important suggested. Maybe the illusion is enough? Especially in the cases explored in the documentaries I've seen where Pepper is used to help with loneliness. Maybe a 'robotic companion' which simply displays an 'illusion' of empathy, as desired by Carol R. Kallend in her poems, will be able to fill that gap where its suggested or thought of as a role only humans can do?*



**Fig.9.** Screenshot from BBC documentary 'Can Robots Love Us?' (2017) of an elderly man dancing with Pepper, after answering 'yes' to the robot's question 'would you like me to be your companion?'

The focus in this essay will now shift to creativity, the other skill set deemed challenging to automate, discussing whether computers can be regarded creatively (using an example of an artist artificial intelligence to explore the act of creativity) rather than focusing on both the ‘creative’ and ‘social’ skills which form machines to acquire, is dubitable. It’s important to note however, that in many cases the two overlap, especially when in the case of collaboration, something that will be touched on as this investigation progresses.

The exploration of human creativity is incredibly complex and it’s almost impossible to define. What it is, how it works and why it works all remain mysterious. The word ‘create’ derives from the Latin word *creāretus* (from the word *creāre* – to make) which translates “to bring into existence”. (Simpson, 1959, p.684) According to many religions, God was the original creator, creating the world we live in today. The Christian religion suggests that God passed the ability ‘to create’ to humans, which are often interpreted to be manifestations of God or made in Gods image. In the Bible, God creates the earth and the creatures on it, then later tells Adam (the first human) to name the creatures.

*“And out of the ground the Lord God formed every beast in the field, and every fowl in the air: and whatsoever Adam called every living creature, that was the name thereof.”* (Genesis 2:19)

The act of Adam naming the animals in this passage, could be understood as a ‘creative act’. Philosopher Nikolai Berdyaev addressed the creative act in his text ‘The Meaning of the Creative Act’ and believed that creativity is an innate ability that can not be measured or explained by science. He states that creativity ‘is something that proceeds from within, out of immeasurable

and inexplicable depths, not from without, not from the world's necessity.' (Berdyayev, 1955, p134) He talked about creativity as a divine act, a facility passed on by God, describing it as an 'anthropological revelation, an unveiling of the Christology of man'. (Berdyayev, 1955, p101) These arguably dated views on creativity suggest that the capacity to create is something only found in humans, an enigmatic skill passed on by a higher being, thus was a reason many struggled to define it.

*What does that mean for computers? Is it possible to program creativity, a 'God like' ability as suggested by Berdyayev, into computers?*

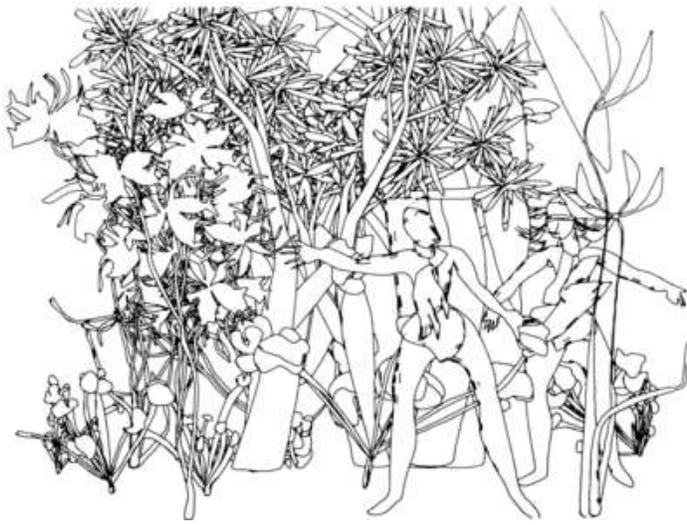
Although even contemporary thinking surrounding creativity struggles to understand what it is, why we have it or how it's possible, it does a better job at defining the skill. Professor of Cognitive Science Margaret Boden researches and writes about creativity, integrating it with her study of AI. Boden describes creativity as the 'ability to come up with ideas and artefacts that are original and valuable.' (Boden, 2004, p.1) With this 'ideas' can be understood as things such as concepts, music, poems, scientific theories, cooking recipes and jokes, whereas 'artefacts' are objects; paintings, sculptures, steam engines, origami and pottery for example. (Boden, 2003) This range of examples just shows how creativity is a part of virtually every aspect of human life, thus everyone of us is creative, to a degree. However, in this study, the term creativity will just be applied to the creative aspect of art and in turn, design. Boden also notes that it's important to distinguish a difference between ideas that are 'psychologically creative' (an idea that is new just to the person who thought of it) and ideas that are 'historically creative' (where this idea is the first in human history, not one has thought of it before). (Boden, 2004)

*These thoughts about creativity all seem to say that it lies just with the creator, but if Boden says that creativity is the ‘ability to come up with ideas and artefacts that are original and valuable’ (Boden, 2004, p.1) who determines its value? A lecture I went to once touched on the ‘creative act’ from the eyes of Marcel Duchamp who suggested that the act of creativity isn’t just completed by the creator but also by who the creation is viewed by. He said once in a talk “the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualifications and thus adds his contribution to the creative act.” (Duchamp, 1957) This makes sense for art I guess, art needs an audience or someone to view it to determine its success or in this case judge its ‘creativity’. Without the spectator, how can a piece of art be measured in terms of success, unless the artist has made work purely for himself and for no one else to see?*

Creativity in humans has been studied and studied for centuries and still remains somewhat a mystery, so it appeared unlikely machines would be capable of such an act, especially for a task in which again, like social skills, we “do not know the rules”. (Astor, 2015, p.23) However, creativity in machines has been explored and arguably achieved in some cases. For example, IBM created ‘Chef Watson’ which analysed over 10,000 recipes, collecting and combing data and detecting patterns in order to create its own recipes, which were published in a cookbook ‘*Cognitive Cooking with Chef Watson: Recipes for Innovation from IBM & the Institute of Culinary Education*’ (2015). Google Magenta, an open source project from Google, can compose its own music and computer comedians such as Manatee and JAPE have the ability to create

their own jokes. Notably one of the most successful of the autonomous creative machines and earliest of its kind, is the artist artificial intelligence robot 'AARON', the robot artist.

AARON is the creation of the artist and professor at the University of California San Diego, Harold Cohen. Cohen was a British artist before his work on AARON, an abstract painter who had studied at Slade and exhibited in galleries across the globe. Cohen's work on the AI program began in 1973 while he was a visiting scholar at Stanford University's Artificial Intelligence Lab. In the 1980's it learnt how to create line drawings of objects or people in 3D spaces and in the 90's Cohen taught it how to paint in colour. It is important to also note that AARON paints with actual paint on canvas via robotics, not pixels, and has the knowledge to mix paints to create desired colours. Even more impressive still, it paints its own portraits of human figures without any means of photos to refer to or via human input. AARON was never shown any images, but instead Cohen taught it relationships between a list of object and body elements. Teaching the machine in this way enables AARON to construct its own abstracted versions of subject matter such as humans or plants without ever seeing what they look like. This way it can explore many more creative, abstracted, possibilities to painting objects rather than simply replicating what they genuinely look like. Without explicit instruction from its creator or human intervention, AARON can paint anything it chooses to within the boundaries of its own knowledge. As AARON'S creative capacity matured so did its paintings, which began with simple line drawings, to portraits of people with the addition of colour to its most recent explorations of colour and shape. The results of AARON's work have been admired by many and have been on display in recognised galleries such as Tate and MOMA.



**Fig.10.** AARON, *Adam and Eve*  
(1986)



**Fig.11.** AARON, *040502* (2004)



**Fig.12.** Painting by AARON, (1992)



**Fig.13.** AARON, *In Zana's room*  
(2012)

*Its pretty amazing that Cohen has taught his machine AARON to do this, but I question the 'creativity' that is happening here. My issue with this is that Cohen himself was an abstract painter and his AI AARON was also creating abstract paintings. Cohen being the machines developer has programmed his machine to produce paintings in an abstract style, a style of painting which was the core of Cohen's own practice. So is the machine actually creating autonomously? It seems to me that AARON is a sort of 'projected' version of its creator, a manifestation of Cohen and his ideas, but in the state of an AI machine, rather than the machine coming up with its own ideas or style of painting. This sort of reminds me of and bares some kind of comparison to Sol LeWitt's instruction based art, where he wrote a set of instructions and hired people to carry out the instructions to produce his artworks. LeWitt would have no part of the production of a mural made for him for example, but the outcome of what was produced lay just with the instructions handed over by himself to the individual(s) acting on the list of rules. Now compare that to Cohen and AARON. Is it much different? Cohen has programmed his machine and told it what to paint, in other words given it a set of instruction via code, and AARON has produced 'artwork'. Who's the artist here? I would be reluctant to say AARON...*

Despite displaying apparent creative capability, is AARON (and the likes of Chef IBM Watson and Google Magenta) truly creative, or are they simply providing an illusion of creativity? It could be argued by many that creativity stemmed from computers is not genuine and can not be compared to human creativity. Suppose the works of so called creative computers were to exceed that of humans, it would still be discredited by these people as showing genuine creativity. Music made by a computer could top the UK charts, computer artists could display works in the Tate

(which has been already been achieved by AARON) or IBM Watson<sup>2</sup> could produce a scientific breakthrough and yet still be disregarded as being truly creative.

*I think there's a difference between the necessity of these forms of creativity. Arguably everyone would say they would like to see a computer like IBM Watson that can accurately diagnose cancer, but do we want or need machines that write music or create art?...*

A strong argument supporting the previous statement asks where the creativity is actually occurring; is it the creativity of the computer or the creativity of the person/persons that produced and programmed it? In the case of AARON, the creator Harold Cohen would be regarded as the creative and not his machine, despite the fact that his computer ultimately produced its own original artwork. Cohen himself agreed with this argument. In his essay 'Colouring Without Seeing: A Problem in Machine Creativity' he states 'I don't regard AARON as being creative; and I won't, until I see the program doing things it couldn't have done as a direct result of what I had put into it'. (Cohen, 1999, p.14). In this comment, Cohen points at another argument against computer creativity. Unless the computer works completely independent of its creators, or any human interaction, it can not be regarded as creative. Cohen later continues to write that he is not suggesting machines can not be creative in the future, but at the time of the comment machines were very far off being completely autonomously creative. In one of his last interviews, Cohen said that while he was working on AARON he was 'probably

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<sup>2</sup> IBM Watson has ability to refer to over 500,000 pieces of medical evidence and search through 1.5million patient records (in real time) in order to make diagnostics for patients. Using this data, Watsons successful diagnostic rate for detecting lung cancer is 96%, compared to 50% for human Doctors.

the only person who considered the computer to be potentially an autonomous art-making entity', (Cohen, 2015) Throughout the time he was alive, Cohen never stated that he thought computers were ever genuinely creative, but always hinted to the future possibility of machine creativity becoming possible at a later point in time. Fast forward to the present, computing has advanced significantly, machines are beginning to learn rather than follow instructions via code, are autonomous in certain job roles (Tesla's driverless cars or Amazons factory robots, for example) and slowly becoming free from the control of humans, yet we still question their creativity in comparison to ours.

*I agree with Cohen's point here, which isn't too dissimilar to my comment earlier. For me, the computer must be acting alone rather than having human input to be considered 'autonomously creative'. With the input from its creator, AARON is almost just a tool of Cohens which he used to make paintings as opposed to a machine that make its own.*

To further help understand what we deem 'creativity' to be, rather than delving into mountains of research lets take a step back and approach the word in the same way we would find the definition of words that we are unacquainted to, via a dictionary.

By dictionary definition, creativity can be defined as:

*"the ability to make or produce new things using skill or imagination"* (Oxford Wordpower Dictionary, 2003, p.159).

Although vague, it is hard to disagree with this as a definition for ‘creativity’, it is concise and makes sense for a general understanding of the word. Now, if for the sake of a quick thought experiment we were to say that our creativity and computer creativity *is* the same (given the anatomical and cognitive differences between humans and machines), would we agree that the definition still makes sense for the latter kind? A computer can easily use skill to produce something new, that can not be doubted, but can it use imagination in order to do so?

‘Imagination’ could be the key word in this definition underlying another reason why many people would argue against the idea that computers can be creative. In short, imagination can be used as a word to describe ‘the faculty or action of forming new ideas, or images or concepts or external objects not present to the senses’ (*Oxford Dictionary of English*, 2006, p.865) and is associated with many things such consciousness, emotion and past experiences. With this in mind, it can be argued that computers can not be creative as the machine isn’t conscious. In the future this may be possible, with vast amounts of research going in to concepts such as whole brain emulation (WBE)<sup>3</sup>, but for now conscious computers are disputably distant.

Without consciousness could a computer shares its own desires, preferences or values with its creations and have an understating of its actions? Could it determine whether its new *idea* or *artefact* is *original* or *valuable*? (Boden, 2004) On the other hand, creativity presented by humans is often delivered with intent, the intention of proposing a new idea, the intention to make someone laugh, the intention to paint a landscape and so on. We then have the ability to judge or appreciate whether said intentions of creativity are successful or not, this comes with

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<sup>3</sup> WBE is the idea ‘to make an exact working copy (or copies) of a particular brain in a non-biological (e.g., computational) substrate’ (Shanahan, 2015, p.15)

consciousness, one thing that computers arguably do not possess. In this case, can a machine really be labelled 'creative' if it can not judge or appreciate creativity itself?

*Duchamp's thinking surrounding the 'creative act' would suggest otherwise. Where he says that the act of creativity is completed by the spectator and is not completed just by the artist, would suggest that a computer wouldn't need to be able to judge its own work. The people viewing it would do that for the machine, completing the creative act. An established artist for example, who would have a critical understanding of their practice could paint something which they perhaps think is successful or beautiful in their eyes, may not be to another person viewing it. The success of an artist's work can't be measured or critiqued by themselves, they need an audience in order to do so. The act of creativity, when it comes to art, extends to whoever is encountering the artwork. This happens to me all the time when I go to galleries. I might see something of interest, make a judgement on it and then when I read the text the intentions or subject of exploration is completely different to what I first thought.*

*I agree in some ways that for me to be able to call a computer or a machine creative then it would have to have some understanding of what it's doing, what it's making or the idea it's come up with. Without this ability its hard for me to call it actually creative. On the other hand, when thinking about the creative act in terms of Duchamp's thinking, I wonder if this ability is even necessary.*

The answer to the question ‘can computers be creative?’ may always remain a subjective one differing from person to person. The main point which seems to make people hesitant to accept computer creativity as ‘genuine creativity’ will seemingly always lie with the fact that machines aren’t human, implying that creativity can only genuinely be produced by the latter. In that case, computers should stop being compared to humans. Instead, maybe we should accept the fact that they are machines and thus we can not compare computer capabilities to ours. However, this does not end the argument over whether they can be creative or not but suggests that computer creativity may well exist, but just in a very different form to what humans are familiar to.

Computer scientist Alan Turing famously wrote a paper ‘Computing Machinery and Intelligence’ in which he created ‘The Imitation Game’ (now commonly known as the Turing Test) which proposed a hypothetical test or ‘game’ in order to consider the question “can machines think?”. (Turing, 1950).

In 2014, the film ‘The Imitation Game’ was released, depicting the true story of Alan Turing and a team of mathematicians who were assigned the task to crack the German Enigma code during World War 2. Turing created a ‘thinking machine’ which manage to crack the code assisting Great Britain to go on and win the war.

A scene in the film The Imitation Game (2014) depicts Turing and a detective discussing whether machines could ever think like humans:



**Fig.14.** Screenshot from the interrogation scene in *The Imitation Game*

**Selected transcript from interrogation scene:**

**Detective Robert Nock**     *Could machines ever think as human beings do?*

**Alan Turing**                 *Most people say not*

**Detective Robert Nock**     *You're not most people*

**Alan Turing**                 *Well the problem is, you're asking a stupid question*

**Detective Robert Nock**     *I am?*

**Alan Turing**                 *Of course machines can't think as people do. A machine is different from a person. Hence, they think differently. The interesting question is, just because something thinks differently from you, does that mean it's not thinking?  
Well, we allow humans to have such divergences from one another. You like strawberries, I hate ice-skating, you cry at sad films, I am allergic to pollen.  
What is the point in different tastes, different preferences if not to say that our brains think differently, that we think differently?  
If we can say that about one another, then why can we say the same thing for brains...built of copper and wire and steel?*

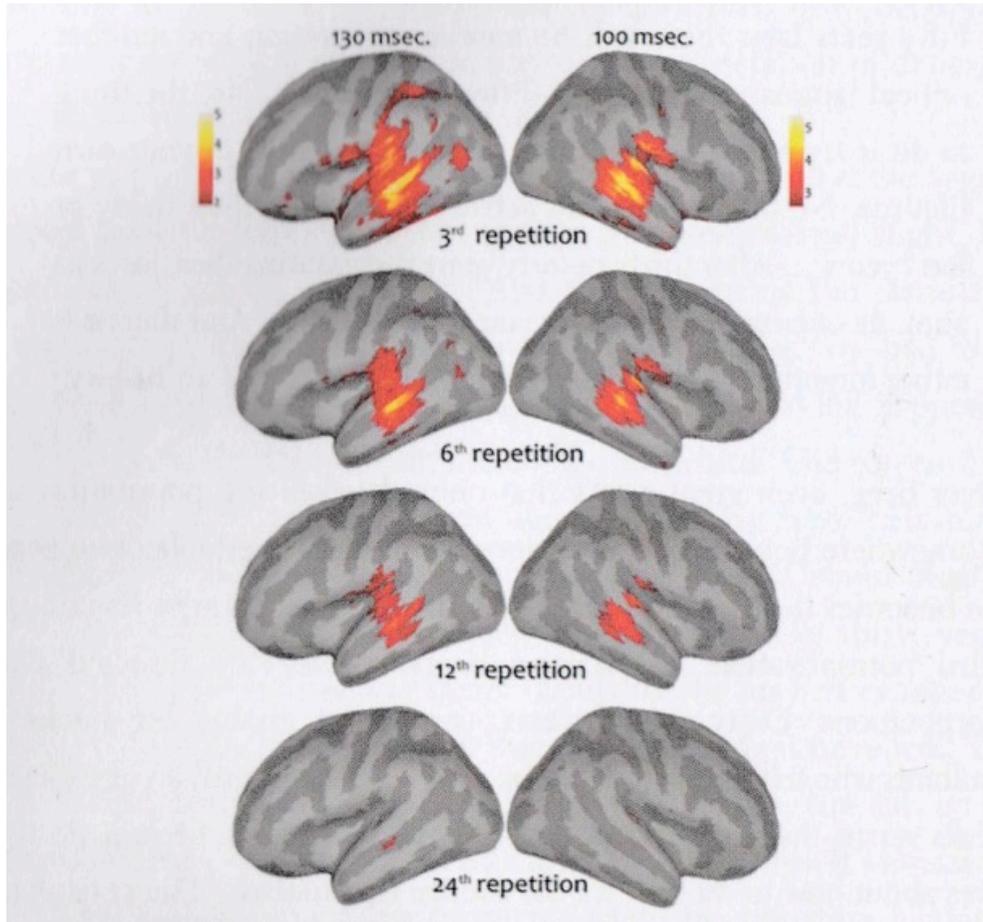
This comment by ‘Alan Turing’ in the film is interesting, especially now if it is applied to creativity instead of ‘thinking’. (It is important to note here that these are fictional quotes from an interrogation scene in a film which are however, heavily based on Turing’s writing and thoughts in his paper ‘Computing Machinery and Intelligence’ written in 1950). In the case of machine creativity, it is not rejecting the idea that computers can be creative, nor is it simply saying they can be, but proposing a different perspective on the matter. We can see in examples such as AARON, Google Magenta or IBM Watson that they clearly display elements of what some may deem to be creative, others would return to the fact that machines are not humans, thus struggle to accept it as what we’re calling ‘genuine creativity’. Just because the creative output from a computer doesn’t involve humanistic inputs such as consciousness, emotion, past experiences for example, this doesn’t mean it should be rejected immediately as ‘creativity’. Instead, we should look at it as a new model or a new form of creativity different to ours, after all *a machine is different from a person.*

In response to A. Turing’s investigation on machine thinking, Prof. Dr. Edsger W. Dijkstra said that the question of whether a computer can think is “as relevant as the question of whether submarines can swim.” (Dijkstra, 1984) What is essential is the effect of tasks carried out by machines, not the process in which the computer completes the task. If a computer written piece of music for example, were able to move you just as much as a piece of music written by a human, is the process of how it was made significant? What is important here is the affect the end creative product has on you. This can be applied other creative tasks such as art, literature, or poetry for example.

*Thinking back to the opinion of Benjamin that the mechanical reproduction of art has the potential to 'lessen a work's aura', (Benjamin, 1936) I believe that a similar thing could be argued in this case of what I suppose we could call an artificial simulation of creativity. Why do we go to galleries, or theatre or concerts? I would say we go because we value the skills or ideas coming from the person or people completing these forms of creative acts, we appreciate the authentic and human aspect of them. An example that shares some similarity could be said for bespoke or hand made goods. They are of more value to us than manufactured goods spat out by machines in factories because we appreciate the craft and skill in which people have produced such items. The same could be said for the idea of a computer simulating human creativeness. We might see computers or machines doing these roles in the future, but would we see it through appreciation or go to see them because of the novelty of machines doing such things? When the novelty of a singing dancing robot wears out, it's surely inevitable we will fall back to the marvelous skill of the human.*

*I would argue that AARON's success was largely due to the fact that it was novel at the time of its creation, and possibly a breakthrough in the relationship of art and science. Its paintings alone weren't actually 'breakthrough' or exciting simply in terms of art or painting, but only innovative in the way it was created by a computer. But that novelty has passed now. Artists haven't been affected by an autonomous art machine and the likes of AARON aren't as 'special' or exciting to see as they were a few years ago.*

However, this isn't to say that computers will thus take over creative jobs if they can complete creative tasks with equally effective results to that of human capabilities. Computers, machines, AI will not stop humans from creating in the same way they will stop us completing manual tasks, so aren't likely to put people out of work. For example, a lorry driver is likely to lose their job to autonomous trucks which in a few years time will have the potential to out perform the human driver. When this happens the lorry driver will not drive his lorry anymore (for work purposes). On the other hand, a creative computer isn't going to stop people from creating, even if they manage to exceed human capability. Autonomous creative machines will not stop people creating in the same way autonomous machines have the potential to make other occupations redundant. Humans will always have an urge to create, we adapt quickly to change, get used to the new and desire newer, thus create newer things. This is due to what cognitive scientists call 'repetition suppression'. Repetitive suppression is what happens to your brain when it sees or acknowledges something repeatedly. Overtime it engages with it less and its stimulation and response is reduced. This is one theory to why things such as art evolves over time, fashion trends change, music progresses, a theory as to why we create new things/versions of things.



**Fig. 15.** ‘Neural activity located in auditory areas shows a suppression of activity when the same stimulus is repeatedly presented (3<sup>rd</sup>, 6<sup>th</sup>, 12<sup>th</sup>, and 24<sup>th</sup>)’ (Brandt and Eagleman, 2017, p.18)

*If computers aren't likely to compete with us in terms of creativity, aren't likely to take creative jobs, does that mean all creative jobs are safe? Does that mean we won't ever need computers to complete creative tasks?*

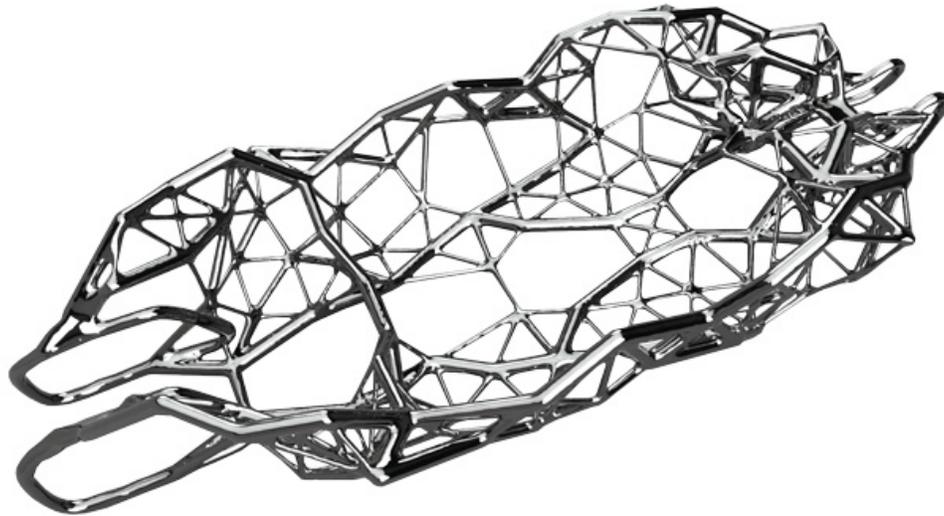
Despite the fact that creative jobs aren't likely to be threatened by creative computers, this isn't to say we won't be seeing them in our workspaces. Returning back to the dictionary quote, there's another word which is interesting to look at in relation to the relationship and comparison of computer creativity. 'Produce'.

*"the ability to make or produce new things using skill or imagination"* (Oxford Wordpower Dictionary, 2003, p.159).

Referring back to Kelly's comment in which he claimed 'productivity is for robots' (Kelly, 2017) it is possible to use artificial intelligence to speed up areas of creativity, or even enhance our own creativity in ways. Not just in a productive sense, where machines already help to boost production aspects of creative work, printing for example, but also with creative thinking and generating ideas/concepts. Computers think differently than us, they 'create' differently than us, so we should, and in the future will in some means of creative work, exploit that and collaborate with their ideas and different ways of thinking. Humans will perform the 'inefficient' tasks suited to them such as applying empathy, constructing ideas and applying 'the human touch' that we desire in the outcomes of creative tasks, with computers carrying out the tasks requiring efficiency to complete a creative job, collecting and analysing data (research) and production for example.

This combined approach to creativity, a collaboration between man and machine opens up creative possibilities that aren't possible for a human, or an autonomous machine alone. The collaboration that brings them together thus creates the possibility for a 'new form of creativity' that wasn't previously possible. Allowing for creations to now be better than previously ever imaginable.

In 2016 software design company Autodesk teamed up with The Bandito Brothers, a creative collective formed of technologists, filmmakers, stuntmen and former athletes that have been known to produce incredible cars, such as life sized Hot Wheels performing world record breaking feats. Their aim was to feed a generative AI system a collection of data in order to produce the 'perfect car'. They did so by driving a car around a desert for a week, a car in which they had strapped a number of sensors to the chassis which over the course of the 7 days captured its every movement. The sensors together collected over 4billion data points of its movements and the forces the car was subjected to. The innumerable amount of data was then plugged into a generative AI design program called 'Dream Catcher' in order to produce the ultimate car chassis. What was produced was something totally alien, something that a human being could never have designed as a result of all the data by themselves. Nor could a machine design it without the input and engineering knowledge of a human, it was the collaboration of the pair that made it happen.



**Fig.16.** Car chassis design produced by generative AI design program Dream Catcher

The incredibly complex structure of the chassis was also almost impossible for the human team to fabricate by themselves, so worked with metal 3D printing technology to produce it. What was produced was the ultimate chassis for their car. Precise, perfectly shaped and balanced, a marvel of engineering.



**Fig.17.** Metal 3D printed chassis

Using Autodesk's project as an example, it's easy to see how AI and 'creative computers' could be used in the future, how the collaboration between man and machine has the potential to be creative beyond our own possibilities. The creativity of the computer then becomes an extension of our own, an augmented capacity for endless creative outputs.

*In a way, the idea of a creative computer acting as a sort of tool, then for art becomes another medium to explore, rather than a threat to the creativity of artists. Like the invention of the cameras opening up so many new branches in art for artists to explore, AI could potentially do a similar thing. Classical oil painter Albert Barqué-Duran did a 3-day live painting performance called 'My Artificial Muse' at Sonar+D, Barcelona (2017). He worked with Mario Klingeman who works with AI and helped produce an AI generative machine which created an image based on the idea of a muse for Barqué-Duran to paint. His aim was to explore whether a 'computer generated muse could be as inspirational as a human-like one'. (Barqué-Duran, 2017)*



**Fig.18.** Image of the muse created by the GAN (generative adversarial network) AI on the laptop of Barqué-Duran being used as a reference image to paint from

*I suppose in this case traditional roles have been flipped. The machine is the creative, the one that has produced the image and the human artist Barqué-Duran is fabricating the computer generated 'art'. Although the concept of the work is human made, the basis of the work revolves around the AI being a source of inspiration and displays its 'form of creativity' to construct the image of the muse for Barqué-Duran to paint.*

*Thinking about this, I could definitely imagine seeing more AI inspired art or art incorporating AI in the future, in a world where artificial intelligence will be more integrated into our lives.*



**Fig.19.** Barqué-Duran alongside his painting at the end of his 3-day performance

The question of whether computers can or will be regarded as genuinely creative will remain a constant ongoing debate, as creativity itself is a particularly subjective topic. However, this could seem pointless as we define creativity based on our own knowledge and experiences of it as human beings. How could we attribute something so seemingly humanistic to machines?

Nonetheless, people will still explore this notion, attempting to achieve the inconceivable task of producing a machine that is comparatively creative to humans. Even if unfeasible, increased research into computer creativity and efforts trying to achieve it, will help us to understand and unpick our own human creativity.

In many ways, 'creative computers' will struggle to compete with humans but on the other hand, have the potential to provide new solutions for creativity. It is unlikely that we will see creative computers operating autonomously, thus replacing the need for human employees in creative fields. However, it is very possible that in the future we will see many creative people working along side AI systems, utilising them in ways that allow for the creation of the unimaginable and unattainable by humans alone.

*I agree, with the idea that 'can computers be creative' is a stupid question, because I feel at the end of the day it is up to whoever is encountering the computers creativity to answer that question, noting back to Duchamp's ideas over the 'creative act'. Nevertheless, let's say the answer to this question is 'yes'. In the case of art, do we need creative computers? Do we want them? Art, to me, is a celebration of humanity. A celebration of expression, our skills and ideas. So the idea of an autonomous art machine seems irrelevant in this case. Art is not the same as jobs such as science where new technologies could be used to help improve our lives, science and the practice of the scientist. Creative computers wont improve art, however they present the possibility for new area in art to be explored. Hence why I do not feel threatened by AI, robots or autonomous machines, but in fact quite excited to see how myself and others will explore and engage with these technologies. I do also understand that 'creativity' isn't simply confined to just art and recognise the potential for creative computers to push our own creativity in fields such as product design, architecture and engineering.*

*Perhaps in the near future, jobs will be automated at levels that supersede the estimate of Frey and Osborne and the majority of all jobs become automated or computerised. Maybe we will live in a world where paid work is rare, due to automation, so we live off global income. Perhaps the challenge to replicate our creativity and convey it in machines still exists and is one of that last human abilities for them to acquire. Will my future self then probe those who once questioned me why I studied art, enquire how relevant their academic studies are in a world of automated labor, a world where creativity is still unique to the human and remains unattainable by the machine?*

*“We demand that art turns into a life-changing force. We seek to abolish the separation between poetry and mass communication, to reclaim the power of media from the merchants and return it to the poets and the sages.*

*We will sing of the great crowds who can finally free themselves from the slavery of wage labor and through solidarity revolt against exploitation. We will sing of the infinite web of knowledge and invention, the immaterial technology that frees us from physical hardship. We will sing of the rebellious cognitariat who is in touch with her own body. We will sing to the infinity of the present and abandon the illusion of a future.”*

- (Berardi, 2011, p.166)

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**Fig.2.** Daimler. (2018) *Driving Autonomously Through Nevada*. Available at: <https://www.daimler.com/innovation/autonomous-driving/freightliner-inspiration-truck.html>. (Accessed: 18 September 2017).

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**Fig.15.** Brand, T. and Eagleman, D. (2017) *The Runaway Species: How Human Creativity Remakes the World*. Edinburgh: Canongate Books LTD. (p. 18)

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