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‘The Robots are Coming!’: Perennial problems with technological progress

ATKINSON, Paul <http://orcid.org/0000-0002-6633-7242>

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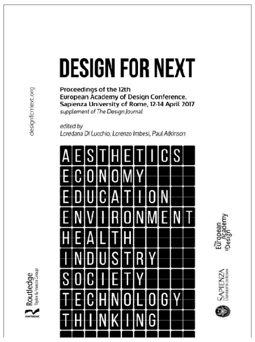

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'The Robots are Coming!': Perennial problems with technological progress

Paul Atkinson[a*]

[a] Sheffield Hallam University
*Corresponding author e-mail: p.atkinson@shu.ac.uk

Abstract: A proliferation of recent media coverage has addressed the latest advances in artificial intelligence. While expressing admiration for its potential, these publications have worried about the negative impact AI could have on the social order. These sentiments are not new. Similar headlines have accompanied articles about computers ever since the first 'Mechanical Brains' appeared. However, archives reveal that experiments in AI have been undertaken for many years, and yet progress has been fairly limited. Yet, no matter how far away true AI might be, concerns about the consequences of technology remain valid. What is it about our relationship with technology that scares us? We appear to be convinced that the technologies we develop will turn out to destroy us. The paper proposes that fundamental changes need to be made in the discourse of technological progress in order for it to be accepted as more of an opportunity than a threat.

Keywords: Artificial Intelligence, Computer Technology, Society, Predictions, Fear

1. Introduction

There has been a proliferation of media coverage recently addressing the latest advances in artificial intelligence (AI). Quality newspapers have regularly been running articles about the subject (A quick look at just one newspaper, *The Guardian* (and its sister paper *The Observer*) over the last 18 months produced 34 significant articles: Adams, 2015; Aitkenhead, 2016; Allen, 2015; Avent, 2016; Bunting, 2016; Burton-Hill, 2016; Chatfield, 2016; Elliot, 2016, 2017; Fox, 2015; Harford, 2016; Harris, 2016; Heritage, 2016; Hern, 2016 (4); Marsden, 2016; McCurry, 2017; McMullen, 2016; Mumford, 2016; Naughton, 2015, 2016 (2), 2017; Parkin, 2015; Sample, 2016; Seager, 2016; Solon 2017; Stewart, 2015; Treanor, 2016; Tucker, 2016; Wales, 2017; Williams, 2016). Several significant academic books on the subject have also recently been published (Barrat, 2013; Frase, 2016; Hanson, 2016; Harari, 2016). While expressing admiration for the potential of AI, most of this coverage has expressed serious concern about the negative impact AI could have on the social order. The titles are telling: A prominent example being the cover of the 25 June 2016 issue of *New Scientist*, which asks 'When Machines Take Over: What will humans do when computers run the world?'

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Alongside this accumulation of articles and books, there has been a recent abundance of popular entertainment titles that address similar issues. It has been a enduring trope of science fiction to portray the perilous possibilities of artificial intelligences gaining human consciousness, but lately this aspect appears to have become even more prominent. Movies such as *Ex_Machina* (Macdonald, Reich & Garland, 2015) and television series such as *Humans* (Fry, 2015) and *Westworld* (Wickham, 2016) serve to proselytize about the potential hazards of AI to a much wider audience.

Clearly, this unease in the media about machines taking over reflects the serious concerns society has about the impact of AI at this moment. Yet, as we know, these sentiments are not new. Harrowing headlines accompanied articles about the first mainframe computers, or 'Mechanical Brains', declaring 'The Robots are Coming!', reporting that 'Our civilization is being invaded by a horde of mechanical men who are determined to change our way of life.' (David, 1953, p. 53) And when 'Electronic Brains' started to appear commercially, an article in *Time* magazine warned that using these machines gave one man the computing ability of 25,000 trained mathematicians (Anon, 1955, p. 81). No wonder people were worried. The hopes of salvation embodied in futuristic technologies appear to have always carried a caveat with them—a fear that we may become the victims of the very technologies we create.

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2. Automatic Writing

It was while researching the topic of how computers had been presented to the public historically that I came across the following information about early attempts at artificial intelligence. The archives, at the Computer History Museum in Mountain View, California, and the Charles Babbage Institute at the University of Minnesota, reveal that experiments in AI have been undertaken for far longer than might be realised, and yet in many respects the advances made seem to have been, for many years, fairly limited. The lack of progress reflected in the lack of change in our own fears referred to above. AI seems to be a harder goal to achieve than many thought.

Scientists have speculated about the jobs that electronic computers would take over from man ever since they were first invented. A chapter in one 1949 text was titled 'The Future: machines that think and what they might do for men.' This chapter contained forecasts of possible roles and problems the computer would solve, and many of them have proved accurate: controlling the temperature in houses, automatic pilots on planes, automatic factories, weather forecasting, business production scheduling, economic forecasting and so on. The author wrote, "This prospect fills us with concern as well as with amazement. How shall we control these automatic machines, these robots, these Frankensteins? What will there be left for us to do to earn our living?" (Berkeley, 1949, p. 189)

The same chapter contained a list of 'Future types of machines that think', which began:

- Automatic Address Book
- Automatic Library
- Automatic Translator
- Automatic Typist [handwriting recognition]
- Automatic Stenographer [voice recognition]

And so shows that a computer storing and producing a written text from a variety of input sources was always expected to be a function of the computer. It is understandable, then, that this turned out to be one of the first areas for experiments in applied artificial intelligence—attempts to have a computer produce original texts of their own creation.

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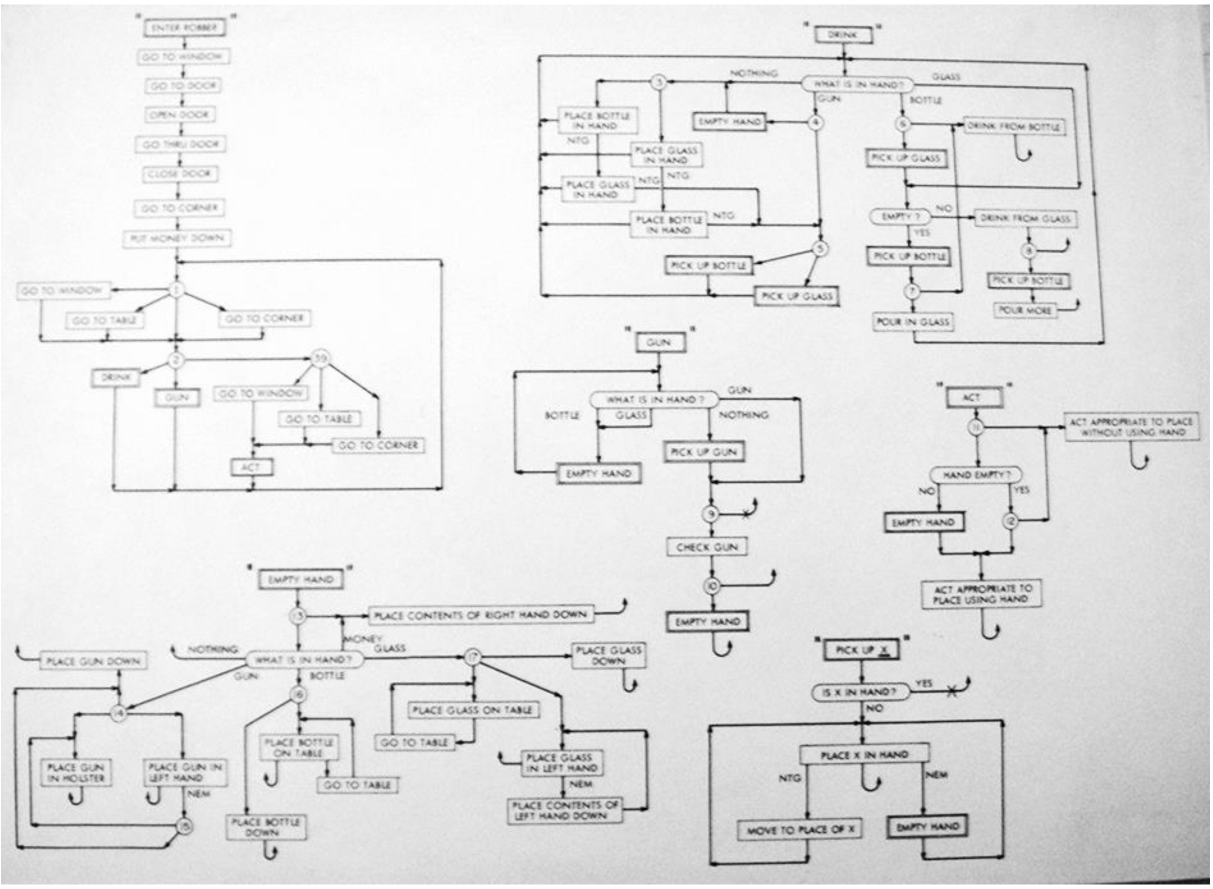
2.1 SAGA II: The Western Computer Playwright

In 1960, a research group at Massachusetts Institute of Technology (MIT)—the Computer Applications Group in the Electronic Systems Laboratory—used the first transistor-based computer called TX-0 to produce the screenplay for a Western. The TX-0, first built in 1956, had originally been fitted with what was then considered to be an enormous memory of 64Kb, but in 1958 this was transferred into the computer's successor, the TX-2, and replaced first with a standard 4Kb of memory, which was later doubled to 8Kb (McKenzie, 1974). The team described the development of 'SAGA II—the TV script-writing Program' in an internal memo as a branching system of possibilities with variables having different probabilities of occurring—for example—deciding if a robber sees the sheriff or not, if he shoots or not, and if he manages to hit, nick or miss him (Morse, 1960). These branching systems resembled complex flowcharts, and which could be randomly selected and used in a variety of ways by the computer in order to produce a storyline. (Figure 1) A press release from American Machine & Foundry Company described the process:

> **TX-0 Digital Computer Developed at MIT Writes Western Drama to be seen on CBS-TV from 10-11 pm (EDT) Wednesday Oct 26**
>
> How does a computer write a Western drama for television?
>
> The answer will be seen in an intriguing and informative hour of television from 10 to 11 pm (EDT) Wednesday, Oct 26, on the CBS TV Network. It will be presented by American Machine & Foundry Company.
>
> But in the meantime, Douglas T Ross, computer scientist at the Massachusetts Institute of Technology, gives an insight into the creative life of a computer-playwright. Ross and several MIT colleagues 'coached' the computer to write a TV drama for 'the thinking machine.' It obliged by writing not one, but two Westerns.
>
> And in the doing, the computer-MIT's TX-0 digital computer-injected a note of originality. In the first computer-written Western, the robber dies in accepted Western tradition.
>
> But in another version, the computer permits the robber to kill the sheriff-hardly the triumph of justice, but it is a new twist to an old tale.
>
> Ross, 30-year-old head of the Computer Applications Group in the Electronic Systems Laboratory at MIT, said the computer, like its human counterpart, builds a Western drama according to a certain set of rules-thus providing a demonstration of what scientists call artificial intelligence.
>
> "But it is not a demonstration that authors are being pushed into oblivion", Ross said, "The chances of ever creating an electronic Euripedes or a transistorized Tolstoy are infinitely negligible."….
>
> The scientists gave the computer a group of things, telling it what properties they had, and gave the computer suggested rules for ways in which they could be put together. This essentially is what a human author does, Ross said….
>
> Ross emphasized that the computer had to be told how to be intelligent….
>
> [To make things more interesting, the computer was encouraged to break the 'rules' of 'intelligent behaviour' by the introduction of 'the inebriation factor'. Everytime a character has a drink, the probability of that character acting intelligently is a little less probable, and unintelligent actions a little more probable.] (American Machine & Foundry Company, 1960)



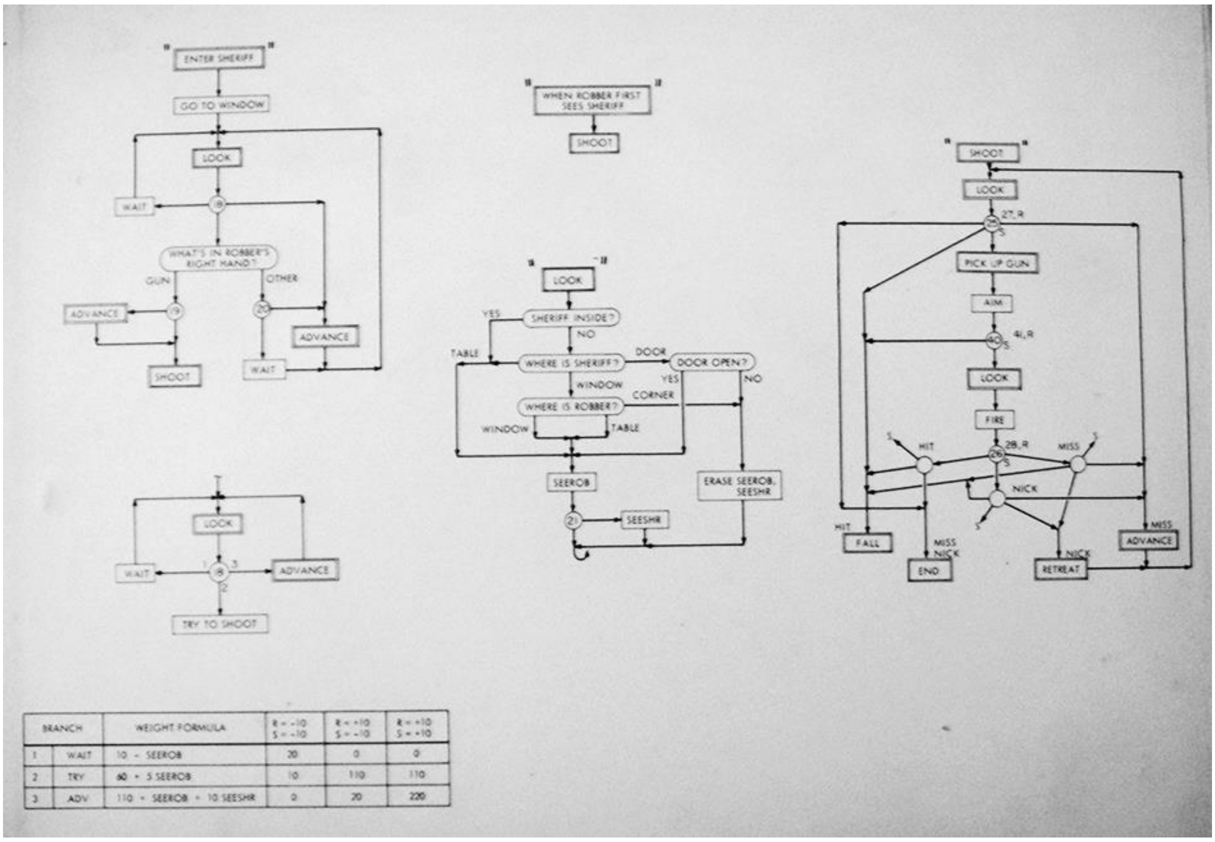


Figure 1. Flowchart diagrams of the routines programmed into TX-0 by the researchers of the Computer Applications Group. The subroutine at the top right of the upper image is titled 'Drink' and introduces an 'inebriation factor' of uncertainty into the possible storyline.

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The event was picked up and reported in the New York Times as follows:

> **News of TV and Radio: Gadgetry by Val Adams**
>
> A machine-written Western playlet, in which a sheriff and a bandit have a gun duel, will be televised this month by the Columbia Broadcasting System. The machine, an electronic computer called TX-0, was developed by the Massachusetts Institute of Technology. Now that C.B.S. is in the act, TX-0 may become the Zane Grey of computers and enjoy many happy residuals.
>
> The two-minute playlet will be presented on “Tomorrow”, a new science series. It begins on Oct 26 at 10p.m. with a one-hour program titled “The Thinking Machine.” David Wayne, the actor, will be seen visiting M.I.T. and talking to scientists about machines that seem capable of reasoning. After Mr. Wayne watches TX-0 type out an ‘original’ Western, the script, which is without dialogue, is performed by two actors. ….
>
> TX-0 was provided with a dramatic situation in which a robber with newly stolen money enters a hideout shack and is overtaken there by the sheriff. The machine, which was ‘told’ that objects in the shack included money, a table, a glass and a bottle of whiskey, then typed out the chain of action and arrived at its own denouement.
>
> C.B.S. will show one version where the sheriff wins and another where the robber is victorious. Then just to demonstrate the TX-0’s reasoning can go off the beam, another script will show the sheriff putting his gun in the robber’s holster, pouring whiskey into a glass but drinking from the bottle.
>
> The following is the last part of one of the Western dramas as it was typed out by TX-0.
>
> SHERIFF: The sheriff is at the window. Go to door. Wait. Open door. Sees robber. Sees sheriff. Go through door.
>
> ROBBER: Take gun from holster with right hand. Aim.
>
> SHERIFF: Aim. Fire Robber hit. Blow out barrel. Put gun in holster.
>
> ROBBER: Fire. Missed. Drop gun. Go to table. Robber dies
>
> SHERIFF: Go to corner. Pick up money with right hand. Go to door. Go through door. Close door. Curtain.
>
> C.B.S. has not provided equal time for real-life writers to appear on the program in rebuttal of TX-0. But Mr. Wayne warns the M.I.T. scientist: “If the computer ever learns to act, I’ll break it’s back.” (Adams, 1960)

The end result of the computer’s efforts—the reality of a series of short directions rather than a piece of descriptive writing—comes as something of an anti-climax after the fanfare with which it was announced, leaving a great deal to be desired.

2.2 Automatic Novel Writing

Moving forward 15 years, a conference paper by a group of computer scientist led by Sheldon Klein was presented at the International Conference on Computers in the Humanities held in Minneapolis in July 1973. The paper, titled ‘Automatic Novel Writing: A status report’ described how Klein’s research team had programmed a Univac 1108 mainframe computer in FORTRAN V (an early programming language) to generate “2100 word murder mystery stories, complete with semantic deep structure, in less than 19 seconds.”

The Univac 1108 was a high-end mainframe scientific and business computer first produced in 1965. It cost around $1.6m in a typical installation, and had over 1Mb of memory. In other words, it was 128 times more powerful than the TX-0 used by Ross and his team at MIT to produce a TV script. Klein's paper went on to state that

> "The techniques draw upon the state of the art in linguistics, compiler theory, and micro-simulation …. The novel writer described herein is part of an automated linguistic tool so powerful and of such methodological significance that we are compelled to claim a major breakthrough in linguistic and computational linguistic research." (Klein, 1973, p.1).

Sounds promising. However, Klein admitted, "The end result is a series of short statements that would in effect provide a 'bare bones' structure that would require adaptation into a script of prose." He wasn't kidding. A series of extracts of the novels appeared in appendices at the end of the report. This is a part of one of the Murder Mystery stories produced on the Univac 1108:

- The cops questioned Heather.
- The Inspector asked the questions.
- The cops searched the drawing room.
- The policemen found a thread.
- The thread was misleading clue [sic].
- Catherine talked with the butler about the murder.
- Cathy said that Dr. Bartholomew was kind.
- The butler agreed.
- Clive was upset about the murder.

3. Towards Artificial General Intelligence

The lack of progress between the script produced on the TX-0 computer in 1960 and that produced on the staggeringly more powerful Univac 1108 13 years later is quite astonishing, and goes to show just how complex these kinds of problems are for computers to solve. Yet we have always expected computers to solve them. Early cartoons of mainframe computers appearing in the 1950s were anthropomorphised to make them resemble human beings, and were depicted as being able to understand hand written instructions fed into them by white-coated operators, and yet in reality, handwriting recognition did not come of age until the end of the 1990s, and even today is not perfect. Other cartoons of 'mechanical brains' showed them responding to spoken commands, and yet voice recognition turned out to be an even harder problem to solve, and remains in a highly inadequate state, as anyone who has used speech recognition software will attest.

So, given the recent proliferation of interest in AI outlined at he start of this article, the question now would be, 'Has any significant change occurred that has renewed scientists belief in the imminence of AI?' Well, according to some (but not all), the answer is 'yes'. The above examples of AI are of the type now referred to by computer scientists as 'narrow' or 'weak' AI, where computers are pre-programmed and trained to master one particular task where there are a finite number of possible actions. A more advanced and better-known example than the automatic writers above, yet one which is still 'narrow' or 'weak' in this respect would be IBM's 'Deep Blue'—a computer that can "beat Gary Kasparov at chess, but would struggle against a three-year-old in a round of noughts and crosses." (Burton-Hill, 2016, p. 16) As shown above, the limitations of such systems are evident. The latest developments in AI, though, concern 'full' or 'strong' AI, and are known as 'AGI'—Artificial

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General Intelligence—defined as Artificial Intelligences that can successfully perform any intellectual task that a human could.

> “We have had machines that can out-calculate us for decades. Now a new wave is outperforming us on tasks ranging from image recognition to video-gaming. They might soon do our jobs better than we can and may even challenge us in areas as sacrosanct as creativity.” (Paul-Choudhury, 2016, p.18)

The video-gaming success Paul-Choudhury is referring to was achieved in 2015 by ‘self-taught AI software’ in the form of an algorithm named ‘Deep-Q Network’, created by DeepMind, an artificial intelligence research company now owned by Google. Deep-Q had learned how to process an input shown on screen, interpret and make sense of it, and take decisions that enabled it to become an expert player of classic Atari 2600 games including *Space Invaders*, *Breakout*, *Boxing*, and *Pong*. “It was a breakthrough that rocked the technology world.” (Burton-Hill, 2016, p. 18). More was to come. Shortly after this breakthrough, DeepMind created a second algorithm named ‘AlphaGo’ to play the ancient Chinese strategy game ‘Go’. In terms of a computing challenge, Go presents a much larger problem than that of chess:

> “Its branching factor is huge: it has more possible moves than there are atoms in the universe; and, unlike chess, it can’t be figured out by brute calculation. Intractable, it is also impossible to write an evaluation function, i.e. a set of rules that tell you who is winning a position and by how much. Instead, it demands something akin to ‘intuition’ from its players: when asked why they made a certain move, professionals often say something along the lines of: “It felt right.”
>
> Computers, for obvious reasons, have traditionally been terrible at making such judgments. Go has therefore long been considered one of the ‘outstanding grand challenges’ of AI, and most researchers expected at least another decade to pass before a machine could even hope to crack it.” (Burton-Hill, 2016, p. 18).

In its creator’s opinion, AlphaGo plays in a very human way because it learned in a human way and then self-improves through practice as a human would, improving its game and getting stronger as it does so. The only difference is that AlphaGo practices continuously: 24 hours a day, every single day, without rest. As a result, despite the difficulty of the challenge, AlphaGo beat the European champion, Fan Hui, 5 games to nil in Autumn 2015, and in March this year, it beat the world champion, Lee Sedol, 4 games to 1. In one of these matches, AlphaGo won by “playing a move that departed from centuries of received wisdom. It can’t express why it did this, but clearly had a rationale.” (Paul-Choudhury, 2016, p.19).

The archival research in section 2 of this paper evidences one of the important distinctions between progress in AI computer software and progress in the computer hardware that runs it. It has been well documented that computer power has progressed at a constant rate since the introduction of the silicon chip. It was the co-founder of the silicon chip company Intel, Gordon Moore, who said in 1965 that the number of transistors in an integrated circuit would double (and that the computer would therefore double in power) every two years. Moore’s Law, as it has become known, has held true now for over 50 years. In stark contrast to this steady state of affairs, developments in AI have tended to have short periods of intense development followed by long fallow periods (as shown by the lack of progress between the two examples shown in section 2):

> “the way most people imagine AI—a machine that thinks like a human—is a remote prospect, unlikely to be fulfilled without a better understanding of how our own minds work. And the field has a history of ‘AI winters’, when development grinds to a halt after a period of rapid advance.” (Paul-Choudhury, 2016, p.19)

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Moreover, when significant jumps in AI are made, they are announced with a deal of fanfare and become lodged in public consciousness through newspaper articles about computers beating humans at Go, or headlines about Google introducing driverless cars. Each time this happens, more predictions are made as to how many job losses are imminent.

It is also the case that the results of AI developments sometimes surprise even the programmers involved when the software behaves in unexpected ways. The programmer of AlphaGo above did not expect the software to make the moves it did, and very recently, when an artificial intelligence machine called Libratus built by Professor Tuomas Sandholm and his PhD student Noam Brown beat four of the world's best poker players in a 20 day tournament, it stunned its makers. Poker was seen as even more of a challenge for AI than Go as it is a game with imperfect information as players cannot see each others' hands, and the game requires the correct interpretation of misleading information in order to win. The makers didn't teach the system to play poker, but gave it the rules and let it learn itself over the course of trillions of hands of poker. So the makers were not confident that it would win, but it did, to the tune of $1.7m in chips, by unexpectedly bluffing and aggressively making huge bets to earn small sums of money. Brown said 'When I see the bot bluff the humans, I'm like, 'I didn't tell it to do that. I had no idea it was even capable of doing that.' (Solon, 2017) If the results of their work surprise those that created it, it is not surprising that many people feel that such developments are cause for concern.

3. The problem of leisure

So is there any difference between the early fears of computers replacing jobs and the impact of AI reflected in the concerns of today? It is true that the jobs the computer was seen to threaten when it first appeared were not labour intensive in the way that the jobs were that were lost to machines during the Industrial Revolution, yet they were repetitive, uncreative tasks—accounting ledger input, payroll and tax calculations, production scheduling and so on. In the past, hindsight has shown that the vast majority of jobs lost to technological progress have been absorbed by other areas of activity, most notably in the rise of service industries, but of course, this cannot continue in perpetuity. And when the jobs being replaced by Artificial General Intelligence include jobs that require creativity, imagination and intuition, a solution may not appear as easily. One explanation for the continuation of fear regarding AI is the awareness people have that the oft-proposed solutions of increased leisure time, funded by the increases in productivity provided by computers, have singularly failed to appear.

Predictions of a shorter working week and an easier life for society, as well as concerns over how we would fill our soon-to-be-extended leisure time enabled by advanced technologies, predate the emergence of artificial intelligence and even the electronic computer by some years. After all, the computer was merely another in a long line of technological inventions that radically changed society throughout the Industrial Revolution that preceded its appearance. At the beginning of the Great Depression, the famous and highly influential economist, John Maynard Keynes, wrote that the economic pessimism being experienced at that time was merely a blip - the result of:

> "the growing-pains of over-rapid changes, from the painfulness of readjustment between one economic period and another. The increase of technical efficiency has been taking place faster than we can deal with the problem of labour absorption; the improvement in the standard of life has been a little too quick." (Keynes, 1931)

Keynes believed that as society would inevitably benefit from further developments in technology of the kind that had fuelled the Industrial Revolution so powerfully, our standard of life would continue

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to improve at an ever-increasing rate. We would, of course, undergo further periods of suffering from ‘technological unemployment’ but this would be ‘only a temporary phase of maladjustment’. He predicted that within the space of one century, i.e. by 2030, mankind would have solved ‘the economic problem’ he had been facing for all of his existence – the struggle for subsistence – and be confronted with an entirely new problem.

> “For the first time since his creation man will be faced with his real, his permanent problem – how to use his freedom from pressing economic cares, how to occupy the leisure, which science and compound interest will have won for him, to live wisely and agreeably and well.” (Keynes, 1931)

Keynes predictions were based on the assumption that although there would be some people for whom material wealth would remain a driving force, most people would be happy to have enough and then work towards helping others, as “everybody will need to do some work if he is to be contented. … we shall endeavor to … make what work there is still to be done as widely shared as possible. Three-hour shifts or a fifteen-hour week.” (Keynes, 1931)

Similar predictions were made in 1933 by the evolutionary biologist and humanist, Julian Huxley. He was convinced that “Fifty years hence … Labour-saving machinery will have so effectively saved labour that four-and-a-half hours will be the average working day” and that this would naturally result in more leisure time. While seeing this as a godsend, he also worried that much more leisure time would present serious issues: “[by 1985] it will have been realized that the problem of leisure is not merely one of finding ways in which not to work,” but “the problem of finding ways of working which people shall enjoy.” (Huxley, 1933) Like others of the time, Huxley assumed the drive to work all hours would disappear.

4. Implications for Design practice

These developments in AI and the accompanying societal changes predicted would certainly have significant impact on the practice of design at all levels if they are realised. At the very pragmatic end of the scale, designing everyday products to be completely manufactured and assembled by robot will merely see a logical extension of practices that have been in place and developing since General Motors first used robots in motor car assembly lines in 1962. (Robinson, 2014) More difficult will be the design of products expected to interact intelligently and understandably with people, and interaction designers face huge hurdles in designing interfaces for AI systems to work with people on a day-to-day basis. At the more idealistic end of the scale, the design of services and support infrastructures more suited to a society where large numbers of people have significant amounts of free time (whether desired or not) and potentially little if any income presents a whole set of much more wicked problems, way outside of the scope of this paper to explore.

5. Conclusions

So, in an attempt to answer the question explored in this paper, our relationship with technology is a double-edged sword. On the one hand, it can bring a huge number of benefits for mankind (with effects ranging from increased lifespan, better health and wellbeing, increased food cultivation and so on) but on the other hand (particularly at an individual level) it often threatens a life of unemployment and poverty. One way to counter this would be to remove the threat of unemployment, and aim for a society where work is carried out on a voluntary basis and more for personal fulfillment as opposed to the pressing need for financial rewards.

Keynes' views turned out to be so wide of the mark because his conclusions were drawn on the assumptions that there would be 'no important wars and no important increase in population', both of which did take place. In addition, he thought "When the accumulation of wealth is no longer of high social importance, there will be great changes in the code of morals." (Keynes, 1931) But people don't seem to have settled for a 'passable' existence. It appears that mankind is not as virtuous or moralistic as he thought.

The problem is one of unrealistically expecting better-off individuals to act in an altruistic way. As one author wrote "faced with the challenge of disruptive new technology, the current political framework is no longer fit for purpose and its shortcomings are likely to lead to a backlash that could turn very nasty." (Elliot, 2016). More fundamental changes in the way individuals are rewarded for contributing to society is required. Moves in this direction have been mooted by numerous government parties and think tanks (including, in the UK, the Royal Society for Encouragement of Arts, Manufactures and Commerce (RSA)), which have put forward the idea of a universal basic income for everyone being provided by the government instead of providing benefits for those out of work, with the option for people add to their income through working. The lower stress and increased mental health benefits of such systems are seen to be enormous. With the basic requirements to live comfortably paid for, people could be free to choose to either support older relatives, concentrate on bringing up children, "or to pursue creative and innovative work that traditionally pays less, like music, arts and invention" (Hodson, 2016, p. 35). Such a system is being trialed this year in Finland and in certain counties in the US, with the aim of removing disincentives to joining the labour force, and enabling people to enter the arena of employment on their own terms. Utopian ideas finally finding traction.

Perhaps new technologies will always provoke worried responses unless there is an underlying change in the social and political systems within which we operate. The rise of Artificial Intelligence and the consequent lack of employment will continue to be a concern for us all as long as we remain within a neo-liberal capitalist system that promotes individual gain over collective wealth. Whatever happens, there will be a considerable impact on design and the expectations made of designers.

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About the Author:

Paul Atkinson is Professor of Design and Design History at Sheffield Hallam University and author of two books on the design history of computers: *Computer* (Reaktion, 2010) and *Delete: A Design History of Computer Vapourware* (Bloomsbury Academic, 2013).

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