Advances in Project Management Series [1]

The quest for artificial intelligence in projects [2]

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Is artificial intelligence the long-awaited answer to all our problems?

Artificial Intelligence (AI) has been described as the most important and disruptive general-purpose technology of our era, especially for large organisations (Benbya et al., 2020; Brynjolfsson & McAfee, 2017). The technology is concerned with building intelligent entities, capable of computing how to act effectively and safely in a wide variety of novel situations, by perceiving, understanding, predicting and manipulating a complex external world (Russell & Norvig, 2022: 19). A preoccupation with such intelligent prediction and engagement within an increasingly turbulent and complex world offers an appealing notion. Indeed, Davenport (2019: xii) maintains that 25% to 30% of large US companies are aggressively pursuing AI, with hundreds, or even thousands of projects under way – many other nations and different business sectors are following suit.

Where does AI come from?

The fascination with the creation of intelligent machines and autonomous agents represents a long-standing craving and desire for the human race. The field of AI traces its roots back to the pioneering work of John McCarthy (Andresen, 2002; Mitchell, 2019). McCarthy selected the term *Artificial Intelligence* in 1955 to distinguish it from the somewhat related area of work known as cybernetics and put together a proposal for a Dartmouth Summer Research Project in 1956 focused on the new area, together with leading scientists Marvin Minsky, Nathanial Rochester and Claude Shannon (see, original proposal, republished as: McCarthy et al., 2006). The proposal endeavours to bring together computer, information and neural scientists and engineers to determine if learning, or any other feature of intelligence can be so precisely described so that a machine could be made to simulate it. Nowadays, this has morphed into a more significant question of whether machines and their computational intelligence can replace, or even improve upon the performance of

[1] *The PMWJ Advances in Project Management series includes articles by authors of program and project management books published by Routledge publishers worldwide. Each month an introduction to the current article is provided by series editor* ***Prof Darren Dalcher****, who is also the editor of the Routledge Advances in Project Management series of books on new and emerging concepts in PM. Prof Dalcher's article is an introduction to the invited paper this month in the PMWJ. See Darren's background and qualifications at the end of this article.*

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human agents, particularly in data rich, demanding contexts. Particularly appealing in this context is the machines' potential to trawl through voluminous data at tremendous speed, and to keep improving and learning how to perform tasks better (i.e. to evolve and transform over time).

To be considered intelligent, a system must not only model a task, but also model the embedded context in which that task is undertaken; this implies sensing the environment and then modifying and adjusting actions accordingly—requiring an ability to make decisions in an uncertain environment (New Scientist, 2020: 8). The original ambition of the scientists around the creation of fully intelligent machines is yet to be realised: Nonetheless, Mitchell (2019) observes that progress has been made on two main fronts. On the scientific side, AI researchers are investigating the mechanisms of natural, or biological, intelligence by trying to embed it in computers (p. 7). On the practical side, significant effort has been devoted to creating computer programs that can outperform humans, without worrying about whether or not such programmes 'think' in the same way as their human counterparts (ibid.).

The relative success of *deep learning*, represented by deep neural networks has (inaccurately) resulted in the use of the term AI to depict this subclass of approaches in the popular media, ignoring large swaths of the discipline of artificial intelligence. Such deep learning is but one type of approach amongst many in the field of machine learning, which itself is a subfield of AI in which machines learn from data or from their own experiences (Brynjolfsson & McAfee, 2017; Mitchell, 2019; Alpaydin, 2020).

Taking its cue from the popular media, management has similarly embraced and adopted deep learning techniques as a proxy for the much wider discipline, perspectives, richness and range of approaches that make up artificial intelligence. It is fair to say that the label of AI has been changing rapidly, but the growing interest in its applicability and wide relevance has encouraged the new prevailing view that AI may be the new IT.

The buzz around AI

Canals and Heukamp (2020) assert that artificial intelligence is redefining the nature and principles of general management by reshaping industries, disrupting existing business models, making traditional business companies obsolete, and creating social change. Indeed, AI is widely projected to transform entire businesses and industries, as well as many human roles and jobs (Kolbjørnsrud et al, 2016; Brynjolfsson & McAfee, 2017; Marr, 2020; Dalcher, 2022). Gill Pratt, the CEO of the Toyota Research Institute, and previous Director at DARPA, makes an analogy between deep learning algorithms and the emergence of vision in animals, 500 million years ago, resulting in the Cambrian explosion, thereby leading to a burst of emerging and novel capabilities (Pratt, 2015). In Gill's view, technological and economic trends are converging to deliver a similar explosion in deep learning capability that could completely revolutionise and transform machine learning and sharing, resulting in a similar burst in new forms and applications that build on the new capability.

AI is already shaping our behaviour and choices. Marr (2020) reminds readers that Alexa, Siri, Amazon's product recommendations, Netflix's and Spotify's personalised lists, dating apps, fitness trackers and every Google search and security check are all driven by AI (or machine learning). They also underpin and enable many other digital technologies from chatbots, facial recognition and self-driving cars to the Internet of Things and virtual reality. Brynjolfsson & McAfee (2017) position machine learning as a general-purpose technology akin to the steam engine, electricity and the internal combustion engine. General purpose technologies unleash, enable and catalyse waves of complementary innovations and exploitable opportunities that can transform society. In their view machine learning offers a similar potential to transform and shape societal development. Two fundamental reasons underpinning the potential are given: Firstly, humans know far more than they can describe and articulate, and machine learning has developed approaches for tapping such patterns (p. 4); and secondly, machine learning systems have become supreme learners, able to detect hidden patterns, such as those related to fraud and disease, and thus are capable of having profound impact on future performance.

What is the potential for collaboration in the project space?

Project management has been tapped as a fertile area for collaboration between humans and machines. But what is the nature of the potential collaboration? Will AI and machine learning reinvent project work? Will machines take over some of the mundane aspects liberating the project manager to deal with people, stakeholders, sponsors, users and team members? What will the new form of project work look like?

The guest article this month seeks to make sense of the amazing potential for change and answer some of the questions. It draws on Peter Taylor's new book, *AI and the Project Manager: How the Rise of Artificial Intelligence Will Change Your World*, recently published by Routledge.

With an ever-growing number of projects and initiatives, the need for success has never been greater. Gartner (2019) predict that by 2030, 80 percent of project management tasks, such as data collection, tracking, reporting, and predictive analysis, will be carried out by AI (and machine learning) in a consistent and efficient manner, allowing leaders to better leverage the technology to support their business goals. Taylor (2021) sets out to explore what this will mean for project managers around the world and tries to prepare them to embrace this technological advantage for greater project success. Given the tremendous investment in projects and initiatives, improving the success rates of impactful delivery can make a huge difference to performance, value and the resulting social good.

Taylor addresses an important need. The project management world needs to understand the potential disruption and prospective dividends from embracing machine learning and AI in such a rapidly moving subject area. Taylor's approach is to identify important insights and offer examples from tech providers and project

experts, in an attempt to create an invaluable resource for PMO leaders, change executives, project managers, programme managers, and portfolio managers.

Taylor predicts the seismic impact of AI and machine learning on the project profession over the next few years. He quotes Dr Athina Kaniouram, the Chief Strategy and Transformation Office at PepsiCo, noting that AI is shaping up to be the single biggest technology revolution the world has ever seen… '*Capable of augmenting natural human expertise, taking automation to new places and diffusing innovation throughout society*'. His work offers an accessible and practical introduction to any member of the global community of change and project management who needs to accept and understand the fast-approaching AI technology, and figure out how to use it to their advantage.

Risks and ethical implications

However, machine learning is not free of risks. New technology, especially when it is powerful needs to be closely inspected through the lens of morality and evaluated for emerging new risks and unexpected and counter-intuitive impacts.

Humans struggle to acknowledge and communicate tacit knowledge. While machines are more capable at capturing the aspects that we cannot articulate by observing and deducing patterns, we are often at a loss to figure out how a machine system has reached particular decisions. It would appear that much like humans, intelligent machines also know a lot more than they can elaborate. Until we are able to create storytelling machines capable of sharing the rationale for their choices, we may be left to speculate the reasoning and the resulting implications.

Knowing when and where to deploy AI and machine learning is critical. Martino-Truswell (2019: 68-70) maintains that all employees need to grasp the answers to the following three key questions regarding machine learning (slightly rephrased and abbreviated):

1. **How does it work?** Employees should understand that machine learning is 'trained' to spot patterns in large sets of data.

2. **What is it good at?** Giving answers within clear parameters defined by people, provided that the machines were 'trained' to solve a problem using vast quantities of reliable data – However, the training is only as good as the data we can source.

3. **What should it never do?** Just because a machine can solve a problem, it does not imply that it should do so. The ethical implications of using AI need to be considered – Machines cannot understand the biases that the data reveals, nor the consequences of the advice they give.

Brynjolfsson & McAfee (2017: 10) identify a number of potential risky implications related to the use of deep learning algorithms (slightly relabelled, and rearticulated below):

- **Hidden biases**: Biases and faulty conclusions can be formed from the data used to train intelligent systems – this could be as a result of replicating previous decisions, or the identification of hidden trends and is likely to remain hidden in subtle interactions in the data, rather than appear as explicit rules, thereby perpetuating or even normalising faulty or biased decisions

- **Lack of verifiability**: The lack of explicit logic rules implies that statistical connections and truths are pursued. It remains difficult to prove that the system will work under all circumstances.

- **Error correction**: It is likely to be extremely difficult to diagnose and correct errors made by systems utilising machine learning. The underlying structure and logic that led to a particular solution is difficult to ascertain, especially when the conditions differ from those the system was trained on. Identifying, understanding and rectifying errors will therefore be immensely challenging.

The future of work in the age of machine learning

Given the promise, what is the future of the workforce in the age of AI and machine learning?

Knickrehm (2019) proposes a range of alternative scenarios ranging from a dystopian world where human and machine will wage a Darwinian struggle that the machines will ultimately win, resulting in massive unemployment, falling wages and wrenching dislocation; all the way through to a utopian scene where intelligent machines will take on even more work, resulting in unprecedented wealth, thus allowing people to apply their talents to more meaningful pursuits. Other scenarios are less encompassing suggesting that some segments will see leaps in productivity and a digital bounty, while others will stagnate, nonetheless offering rapid advances for high performing and well positioned organisations.

Organisations can endeavour to position themselves to thrive in the new era. Yet, Davenport (2018) counsels caution, noting that AI offers solid, rather than spectacular business value given that such technologies are destined to augment, rather than replace human workers, as smart machines work alongside smart people. Indeed, there are a number of actions required to shape the workforce for the future by rearranging and planning for a division of capabilities (based on Knickrehm, 2019, slightly abridged and rephrased):

Use technology to augment human skills and reinvent operating models: Invent intelligent new working arrangements removing awkward, dangerous, routine or tiring jobs, whilst offering employees new tools to improve customer experience and

discover new possibilities for products, services and business models that can drive growth.

Take the opportunity to redefine jobs and rethink organisational design: Reconfigure remaining jobs by adding new tasks or creating new roles needed for managing intelligent technologies. Develop intelligent enterprises allowing collaboration across functional and operational silos enabling quick action and the deployment of talent on problems, experiments and iterations needed to get solutions to market.

Make employees your partners in building the intelligent enterprise: Look to upskill employees emphasising prised human skills such as creativity, empathy, communication, adaptability and problem solving.

Human-technology collaborations

Marcus & Davis (2019) qualify the achievements in the field of AI, noting that they have been limited to relatively closed systems with fixed sets of rules rather than addressing open ended and ever-changing contexts. Funk (2020), similarly predicts that despite the growing hype, AI will take years to significantly boost economic performance, and therefore forecasts a gradual evolution rather than a transformative revolution. Moreover, Gibbons (2019) demonstrates that the more technologically-enabled that workplaces become, paradoxically, the greater their need for humanising business and emphasising aspects such as community, purpose, connection, empathy, relationships and trust.

Humans and AI technologies have different strengths and capabilities. Technology can therefore be used to augment and complement human capabilities. Collaboration between humans and artificial intelligence takes into account what machines excel at, how machines can augment and enhance what humans do, what humans are distinctly good at and how to shape business processes in order to enable and sustain the collaboration that builds on and maximises the strengths of both parties. Wilson & Daugherty (2018) emphasise such collaboration through a set of five fundamental principles:

- Reimagine business processes
- Embrace experimentation and employee involvement
- Actively direct AI strategy
- Responsibly collect data
- Redesign work to incorporate AI and cultivate related employee skills

Results based on a survey of 1,075 companies in 12 industries indicate that the more of the principles that are adopted by companies, the better their performance when measured in terms of cost savings, revenue or other operational measures. Those adopting all five principles of collaborative AI had their performance improved by a factor of 6.5 compared to those who adopted no AI (p. 115). For reference, companies

who adopted non-collaborative AI still had an improvement by a factor of 2 over those who eschewed AI altogether, but the higher rates were reserved for organisations embracing the principles of collaboration. The most significant improvements occur when humans and machines work together; attempts to replace humans see only short-term productivity gains – the real value stems from strategic and collaborative efforts to enhance complementary strengths, leading to superior capability.

Partnership requires understanding and proper positioning of strengths and complementarities. There are distinct roles and strengths that are required for a successful collaboration. Wilson & Daugherty (2019) identify three key roles for humans:

- *Training* machines to perform certain tasks, by identifying the right datasets;
- *Explaining* the results of such tasks, especially when the results are opaque, counterintuitive or controversial;
- *Sustaining* the responsible use of machines, by ensuring that they are functioning properly, safely and responsibly.

In return, smart machines can expand human capabilities. This can be done by:

- *Amplifying* cognitive strengths and boosting analytic and decision-making abilities by providing the right information at the right time;
- *Interacting* with customers and employees in novel and more effective ways to free them up for higher level tasks;
- *Embodying* human skills to extend our physical capabilities.

Augmentation and reapportioning of capabilities according to the respective strengths of humans and machines can underpin the reimagining of business and the redesign of operation, resulting in greater flexibility, speed and scale. It also supports better informed and more timely decision-making, and opens the potential for tailoring and personalisation for customers and users and more creative and strategic use of human resources and capabilities.

The moral dimension

'*Technology is giving life the potential to flourish like never before–or to self-destruct*.'
- Future of Life Institute

There is a lot more to understand about how humans and machines can best work together. Substituting people with technology is not merely an exercise in efficiency and economics (Pfeffer, 2020: 73). Managers utilise their contextual knowledge of organisational history and culture as well as their empathy and ethical reflection in deriving their human judgements (Kolbjørnsrud et al., 2016), whilst the models and algorithms underpinning big data choices tend to be opaque, unregulated and incontestable—often reinforcing discrimination (O'Neil, 2016). Indeed, Birkinshaw (2020: 26-7) notes that while AI can improve the quality of decisions, it also creates

new risks and blind spots, including analysis paralysis, loss of contextual understanding, and loss of differentiation, thereby impacting the value of strategic thinking.

'*Even though many observers think of AI as a potentially liberating force, my analysis suggests it is more likely to serve as a constraint on the actions of executives and the activities of the firm*.' (Birkinshaw, 2020: 33)

Pfeffer (2020) emphasises the importance of human sustainability and well-being at the very core of organisational performance. Pfeffer also raises a concern for an inevitable tendency to substitute people with machines for purely economic reasons (p. 72-3) – a tendency that could potentially render organisations less feeling, emotional and moral. Other commentators observe the potential for the problem of control—retaining absolute power over machines, and developing ways to ensure that they (continue to) remain beneficial to humans (Russell, 2019). The increasing use of algorithms to make ever more important decisions raises fundamental moral questions. Machines learn through carefully selected and curated data sets. But the conclusions and learning may not reflect human values. The question of how to teach human values remains a difficult challenge requiring measures of fairness and transparency that are not always visible or enforceable in learning systems.

Pablo Picasso observed that '*computers can only give you answers*'. When we use them, it is therefore incumbent upon the rest of us to pose the right questions. The *alignment problem* reflects the need to verify and protect human values when machine learning is allowed the freedom to learn and grow (Yudkowski, 2016; Christian, 2020). For instance, how do we ensure that learning machines do not acquire sexist, racist or immoral thinking patterns as they learn from past datasets, or by observing current trends and correlations? Indeed, how do we encourage and foster the identification of the human values that we hold dearest in machines that are trained to observe patterns and rules in large data sets, whilst also ensuring that their decisions and choices remain moral and acceptable? Alignment is a worthy target, but its pursuit requires sensitivity and a fair amount of learning and alertness from all participants, which requires us to continue to aspire to more.

The organisation of tomorrow can learn from the past

Van Rijmenam (2019: 115) observes that the organisation of tomorrow will be built around data and will require smart algorithms to make sense of all that data – thereby empowering employees and customers and putting the smartness to work. If AI is the new IT in the era of deep learning, as is often asserted, are there any lessons that can be learnt from the application of technology in IT?

The impact of technology on organisations has proved to be a promising area for research. IT has long been perceived as a socio-technical arena, where the social concerns related to participants and actors interact with the technology being deployed. Changes in technology, impact users, whilst evolving understanding, user

expectations and usage patterns may combine to shape the technology itself. In other words, the social and the technical are closely entwined (see for example, Emery & Marek, 1962; Trist, 1981; Mumford, 1995; Mumford, 2000; Scacchi, 2004; Mumford, 2006).

Perceiving technology as both a physical object and a social product positions it as an enabler, operating between action and structure (Orlikowski & Robey, 1991), playing an important part in shaping the nature of the organisation design, intelligence and decision making (Huber, 1990). Technology is thus deemed capable of both facilitating and constraining social action by offering new affordances and reconfiguring organisational structure (Van Rijmenam, 2019: 12). The ways technology is deployed and utilised is now known to create structures that in turn shape both the social and material aspects of organisations, introducing an element of performativity.

Socio-material practices (invoked in a recent article exploring the impacts of standards, in Dalcher, 2021), recognise that organisations are created by material forms and spaces through which humans act and interact (Orlikowski, 2007; 2010; Orlikowski & Scott, 2008; Leonardi, 2012). Organisations deploying new technologies become closely entwined in both social and material aspects as they become interlocked, co-influencing and co-shaping one another. The entanglement of the social and the material is central to ascertaining the impacts of the introduction of new technologies. Closely enfolding social, material and organisational aspects – is critical to shaping behavioural, moral and even governmental aspects. The practices that are employed, thus play their part in shaping and altering the configuration of rules, structures, norms and expectations.

The promise of new technologies and the actual actions and practices involved in deploying them inside organisations, thereby combine to shape their perception, usage and impacts. Past experience from IT confirms that blending people and technologies can lead to potent new arrangements and ways of working. These in turn, can be used to maximise benefit, but may also harbour and accentuate new risks, and moral hazards. Perhaps the trick with new technologies, however promising, is to appreciate both the social, the material and their entangled co-existence and to attempt to recognise the complex network of impacts and influences.

In Greek mythology, Icarus perishes when he tests his new technology to the limit by flying too close to the sun, causing the wax in his wings to melt. Successful use, can often reduce safety margins, enticing us to try to fly that little bit closer to the sun, in a sudden burst of overconfidence. The same characteristics that drive success, can also harbour the seeds of failure, when taken a step too far. New technologies can offer a great potential for transformation, but their use and deployment as we seek to explore the new boundaries, should always be regarded as an ongoing experiment, by proceeding one cautious step at a time.

References

Alpaydin, E. (2020). *Introduction to machine learning*. Cambridge. MA: MIT press.

Andresen, S. L. (2002). John McCarthy: father of AI. *IEEE Intelligent Systems*, *17*(5), 84-85.

Benbya, H., Davenport, T. H., & Pachidi, S. (2020). Artificial intelligence in organizations: What it can – and cannot – do for your organization. *MIS Quarterly Executive*, *19*(4).

Birkinshaw, J. (2020). What Is the Value of Firms in an AI World? In Canal, J. & Heukamp F. (Eds.) *The Future of Management in an AI World* (pp. 23-35). Cham, Switzerland: Palgrave Macmillan.

Brynjolfsson, E., & McAfee, A. (2017). The business of artificial intelligence: how AI fits into your data science team. *Harvard Business Review*, *98*(4), 3-11.

Canals, J., & Heukamp, F. (2020). *The future of management in an AI world*. Cham, Switzerland: Palgrave Macmillan.

Christian, B. (2020). *The alignment problem: Machine learning and human values*. New York: WW Norton & Company.

Dalcher, D. (2021). The power and peril of common standards: Knowledge and standards in project-work. *PM World Journal*, *10*(11), 14pp. https://pmworldlibrary.net/wp-content/uploads/2021/11/pmwj111-Nov2021-Dalcher-the-power-and-peril-of-common-standards.pdf

Dalcher, D. (Ed.). (2022). Rethinking the future of project management, in, Dalcher, D. (Ed). *Rethinking Project Management for a Dynamic and Digital World*. Boca Raton, FL: Routledge, pp. 2-21.

Davenport, T. H. (2018). *The AI advantage: How to put the artificial intelligence revolution to work*. Cambridge: MA: MIT Press.

Davenport, T. H. (2019). The state of AI in business. In *Artificial intelligence: The insights you need from Harvard business review*. Boston: Harvard Business Review Press.

Emery, F. E., & Marek, J. (1962). Some socio-technical aspects of automation. *Human Relations*, *15*(1), 17-25.

Funk, J. (2020). Expect evolution, not revolution: Despite the hype, artificial intelligence will take years to significantly boost economic productivity. *IEEE Spectrum*, *57*(3), 30-35.

Gartner (2019). How AII will reinvent program and portfolio management. Stamford, CT: Gartner.

Gibbons, P. (2019). *Impact: 21st century change management, behavioural science, digital transformation and future of work*. Boston: Phronesis Media.

Huber, G. P. (1990). A Theory of the Effects of Advanced Information Technologies on Organizational Design, Intelligence, and Decision Making. *The Academy of Management Review*, *15*(1), 47-71.

Knickrehm, M. (2019). How will AI change work. In *Artificial intelligence: The insights you need from Harvard business review*. Boston: Harvard Business Review Press.

Kolbjørnsrud, V., Amico, R., & Thomas, R. J. (2016). How artificial intelligence will redefine management. *Harvard Business Review*, *2*, 1-6.

Leonardi, P. M. (2012). Materiality, sociomateriality, and socio-technical systems: What do these terms mean? How are they different? Do we need them. In, Leonardi, P. M., Nardi, B. A., & Kallinikos, J. (Eds.). (2012). *Materiality and organizing: Social interaction in a technological world*, Oxford: Oxford University Press, pp. 25-48.

Marcus, G., & Davis, E. (2019). *Rebooting AI: Building artificial intelligence we can trust*. New York: Vintage.

Marr, B. (2020). *Tech trends in practice: The 25 technologies that are driving the 4th industrial revolution*. Chichester: John Wiley & Sons.

Martino-Truswell, E. (2019). Three questions about AI that nontechnical employees should be able to answer. In *Artificial intelligence: The insights you need from Harvard business review*. Boston: Harvard Business Review Press.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). A proposal for the Dartmouth summer research project on artificial intelligence, august 31, 1955. *AI magazine*, *27*(4), 12-14.

Mitchell, M. (2019). *Artificial intelligence: A guide for thinking humans*. London: Pelican Books.

Mumford, E. (1995). *Effective systems design and requirements analysis*. London: Macmillan International Higher Education.

Mumford, E. (2000). A socio-technical approach to systems design. *Requirements engineering*, *5*(2), 125-133.

Mumford, E. (2006). The story of socio-technical design: Reflections on its successes, failures and potential. *Information systems journal*, *16*(4), 317-342.

New Scientist (2020). Artificial Intelligence: The past, present and future of machines that think. New Scientist Essential Guide. London: New scientist.

O'Neil, C. (2016). *Weapons of math destruction: How big data increases inequality and threatens democracy*. New York: Broadway Books.

Orlikowski, W. J. (2007). Sociomaterial practices: Exploring technology at work. *Organization studies*, *28*(9), 1435-1448.

Orlikowski, W. J. (2010). The sociomateriality of organisational life: considering technology in management research. *Cambridge journal of economics*, *34*(1), 125-141.

Orlikowski, W. J., & Robey, D. (1991). Information technology and the structuring of organizations. *Information systems research*, *2*(2), 143-169.

Orlikowski, W. J., & Scott, S. V. (2008). 10 sociomateriality: challenging the separation of technology, work and organization. *Academy of Management annals*, *2*(1), 433-474.

Pfeffer, J. (2020). The Role of the General Manager in the New Economy: Can We Save People from Technology Dysfunctions? In Canal, J. & Heukamp F. (Eds.) *The Future of Management in an AI World* (pp. 23-35). Cham, Switzerland: Palgrave Macmillan.

Pratt, G. A. (2015). Is a Cambrian explosion coming for robotics?. *Journal of Economic Perspectives*, *29*(3), 51-60.

Russell, S. (2019). *Human compatible: Artificial intelligence and the problem of control*. London: Allen Lane.

Russell, S., & Norvig, P. R., (2022). *Artificial Intelligence: A modern approach, 4th edition*. Harlow: Pearson.

Scacchi, W. (2004). Socio-technical design. *The encyclopedia of human-computer interaction*, *1*, 656-659.

Taylor, P. (2021). *AI and the Project Manager: How the Rise of Artificial Intelligence Will Change Your World*. Abingdon: Routledge.

Trist, E. L. (1981). *The evolution of socio-technical systems* (Vol. 2). Toronto: Ontario Quality of Working Life Centre.

Van Rijmenam, M. (2019). *The Organisation of Tomorrow: How AI, Blockchain, and Analytics Turn Your Business into a Data Organisation*. Abingdon: Routledge.

Wilson, H. J., & Daugherty, P. R. (2018). Collaborative intelligence: Humans and AI are joining forces. *Harvard Business Review*, *96*(4), 114-123.

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