

Chapter 7

Algorithmic management of humans

On 2 November 2005, Amazon launched a new crowdsourcing service called Amazon Mechanical Turk. Known simply as MTurk, the service offers modest payments to individuals willing to carry out small tasks. The jobs available in the marketplace included posting 10 short messages to a fan site forum (\$0.50) and transcribing a short podcast (\$2.31).¹ In less than two years, over 100,000 workers registered into the system from more than 100 countries. The gig economy was born.

The significance and innovativeness of MTurk did not lie in opening a marketplace to buy and sell work online but, rather, in its automated management of workers. The term *micro-outsourcing* had already been coined by *Computer World* magazine in May 2000 to capture online marketplaces for work. Earlier, micro-outsourcing platforms had enrolled rosters of skilled workers who could be contracted to carry out small tasks that matched their skills and schedules. Unlike these earlier platforms, Amazon's MTurk shifted focus from skilled workers to well-defined tasks and helped to eliminate all human interaction in commissioning and delivering work. Without the need for human interactions, Amazon MTurk soon reached a scale beyond anything seen before. It was the first to tap into a large global network of potential workers by creating the online crowdsourcing market for later entrants, such as CrowdFlower and CrowdSource.

The underlying philosophy of MTurk stands in stark contrast to the basic understanding of human work. MTurk was a human–software hybrid conceived as an extension to diverse information systems, an auxiliary that used humans to complete tasks that were inconveniently complex for the computer. The one-paragraph press release announcing the service in 2005 is still active online (in 2020). It reads:

Today, humans still significantly outperform the most powerful computers at completing such simple tasks as identifying objects in photographs—something children can do even before they learn to speak. However, when we think of interfaces between human beings and computers, we usually assume that the human being is the one requesting that a task be completed, and the computer is completing the task and providing the results. What if this process were reversed and a computer program could ask a human being to perform a task and return the results? What if it could coordinate many human beings to perform a task?

Though, technically, it was a relatively modest platform, MTurk can be seen as a radical step in pioneering an entirely new way of organizing work. In this new scheme of things, workers do not form part of an organization or occupy specific work roles. They are an interchangeable mass of resources to which the IT system is able to delegate tasks as though it were invoking another computer service. The seamless connection of computer algorithms and tasks has led directly to the rise of Uber, Deliveroo, and other similar gig economy services.

¹ These examples are from a 2007 post on the blog website Coding Horror.
<https://blog.codinghorror.com/is-amazons-mechanical-turk-a-failure/>

Before Amazon launched the MTurk platform, it had pioneered the use of humans as auxiliaries to IT systems internally.² The introduction of third-party sellers created usability problems with duplicate product listings, poor categorization of products by external sellers, and uninformative photographs. Amazon wanted to take control of the user experience, collating duplicate listings, verifying the accuracy of categorization, and curating photographs. At the time, eBay would list a single product—say, a Canon 24-70mm f/2.8L EF L-Series Standard Zoom Lens USM—under a dozen or more different names, hindering the ability of potential buyers to locate and compare products. Jeff Bezos wanted to group all the sellers of any given product on one single page, something eBay considered too difficult or costly to accomplish. The scale of the task is, indeed, greater than one may intuitively think: in December 2017, Amazon was selling about 400 million different products on the US website, many of which were offered by dozens, or even hundreds, of different sellers.

Amazon had to develop an automated process because the task was too difficult for artificial intelligence (AI) algorithms to accomplish reliably, and the use of an internal workforce was prohibitively expensive. Amazon solved the problem by devising the MTurk system to outsource these tasks to an external workforce that was paid per task, rather than receiving a salary. Grouping the products sold by multiple sellers within the same product identity provided a winning feature. The superior user experience was one of the reasons why Amazon quickly caught up to eBay as a marketplace for small vendors.

The merging of man and machine brought about by Amazon is far more prosaic than the physical fusion depicted in the Robocop movies and William Gibson's cyberpunk novels. While science-fiction writers expected machines to be merged into human bodies to provide humans with new abilities, we are, instead, seeing humans being connected to algorithms to serve the goals of the computer system.

Working for an algorithm

The role reversal of machines and men profoundly changes the experience of workers, who can find themselves managed by a computer system. In 2015, a group of researchers at Carnegie-Mellon University introduced the term 'algorithmic management' to capture the phenomenon.³ The authors define algorithmic management as 'software algorithms that assume managerial functions and surrounding institutional devices that support algorithms in practice'. They illustrate the concept with the drivers of the taxi services Uber and Lyft, Starbucks baristas, and UPS deliverymen, all receiving their commands from an algorithm through a mobile app.

Yet, the significance is not what software can do, but what it eliminates: a human contact. When information systems are able to provide commands, measure performance, and give appropriate feedback and payments, the need for a human supervisor disappears. By eliminating the human between an information system and

² Amazon obtained a patent for the mechanism of decomposing tasks for human processing with a somewhat menacing name: Hybrid machine/human computing arrangement. US patent no. 7197459, filed in 2001 and granted in 2007, records Venky Harinarayan, Anand Rajaraman, and Anand Ranganathan as the inventors.

³ The term is introduced Lee *et al.* (2015).

workers, companies create a new kind of work role that is controlled almost solely by algorithms. This relationship between the system and the worker is highly asymmetric; the system applies predefined rules in its interactions with the workers, who can only acquiesce or walk away. Voicing concerns becomes difficult.

The new relationship between information technology and human work enables businesses to conceive work as an abstract flow disconnected from the individuals who deliver it. Amazon CEO and founder Jeff Bezos has called the system ‘humans-as-a-service’, illustrating how work is being decoupled from the workers. Moreover, Amazon refers to the work done by the gig workers on the MTurk platform as human intelligence tasks, for which it has coined the acronym ‘HITS’. Somewhat ironically, the attempt to create computers that mimic human intelligence has been reversed: Amazon officially characterizes MTurk as ‘artificial artificial intelligence’. MTurk offers humans work as a substitute for something companies would really want: an intelligent machine. Implicit in the terminology is the expectation that, as AI technologies inevitably improve, HITS will soon no longer be needed.

The data imperative can be seen at work in the proliferation of algorithmic control. While the use of information systems to control work is not a new phenomenon, the prior incarnations of algorithmic management have been limited to such narrow specialty areas that they have been largely ignored. For example, IT systems have long generated picking lists for warehouse workers and monitored their progress. The spread of algorithmic management has extended the reach of data-driven optimizing into numerous labour-intensive processes. Amazon’s real insight lies in the need conceptually to disconnect human work from heterogeneous individuals and turn it into an amorphous mass of labour that can be called up to execute tasks predictably. By disconnecting work from workers, it becomes subject to optimizing through smart algorithms and flows of real-time data.

The ubiquity of cheap smartphones led to the extension of the algorithmically controlled workforce from its initial incarnation as mental work behind a keyboard to an increasing range of physical tasks. Many algorithmically controlled roles are mobile, typically exemplified by employees or contractors who communicate and take commands from information systems through mobile phone apps. The ability to track physical location through GPS allows food delivery companies, such as Deliveroo and Foodora, to monitor their employees remotely and to provide them with automated commands and performance feedback without any human intervention.

Nobody knows exactly how many employees are predominantly subjected to algorithmic management, receiving their instructions and performance feedback from software systems rather than humans. There are, however, more detailed statistics on a major facet of algorithmic management: the so-called gig economy. A recent report by the International Labor Organization (ILO) suggests that millions of individuals already work in app-based, on demand services and ‘crowdwork’ platforms.⁴ Independent contractors who work in the gig economy represent the pioneers of algorithmic management and illuminate developments that are also taking place inside corporations.

I interviewed several front-line workers in the gig economy to better understand the practicalities of algorithmic work. One of them was Akseli, an actor living in Berlin. In

⁴ De Stefano (2016).

many ways, he is a typical example of the reliably atypical subcontractors who work on bikes in the food delivery business. When I interviewed him, he was just finishing a five-month stint as a cycle courier. During that time, he had regularly logged into the Deliveroo mobile app, accepting orders from Deliveroo's information system, cycling to restaurants to pick up food, and delivering them to the homes of Deliveroo's customers.

For Akseli, delivering food on a bicycle provided a temporary and convenient way to earn a living between artistic projects. Deliveroo's workforce in many cities consists mostly of mobile students and recent graduates, who are employed to facilitate the busy lives of young professionals. According to Akseli, most of the food deliveries in Berlin went to a few 'hip' affluent neighbourhoods. When the business was good, he would do two to four deliveries an hour—a statistic that many of the couriers followed meticulously on the Deliveroo app. When demand was lower, or more independent couriers had signed up in a shift, he spent time waiting for orders to show up. With pay at around €5 per delivery, his rate of hourly earning ranged between €5 and €20. After mandatory health insurance costs of more than €350 a month, the money was far from great. But Akseli had no complaints—it paid the bills and kept him fit.

Deliveroo has been unable to eliminate human control of the workforce completely, but the role of human oversight is closer to that of administrative support, rather than that of management. When facing problems with restaurants and customers, a frequent occurrence, Akseli and other couriers interacted with the company through a chat channel on the app. The couriers interacted with their own name, while the Deliveroo support staff used an anonymous chat handle. Akseli described the impersonal feeling: 'I would regularly joke with the anonymous service person. It was quite weird not to know if this was a person who already knew me from previous chats or someone with whom I had never interacted.' The anonymity seems appropriate to the impersonality of algorithmic management and the detached role of the algorithmically controlled workers.

While algorithmic control was initially largely confined to independent contractors, it is not limited to the gig economy. One of Deliveroo's fiercest competitors, Foodora, has chosen to employ all of its couriers with regular employment contracts in Berlin, while using a very similar algorithmic management system to direct and control their work. The established employment relationships have ensured that the supply and quality of the workforce is more predictable, even if it has somewhat reduced the flexibility in staffing.

Established corporations are unlikely to replace their employees with external contractors, but they are much more likely to implement mobile apps and algorithms to manage their workers, the intent being the initial reduction and ultimately the total elimination of the role of human supervisors. In contexts where digital data is readily available, individual decisions can be moved from humans to computer systems. For example, the Hong Kong underground system now uses an advanced information system to assign tasks to its engineers. The system uses historical data to prioritize repairs and maintenance work, assigning work so as to minimize the cost and disruptions caused by failure or maintenance.⁵

Algorithms can arguably be more consistent and fairer than humans, and they may also end up protecting companies from legal perils related to labour law. Providing a

⁵ *New Scientist* (2014, 2 July). As a side note, it is debatable whether the genetic algorithm used by the organization to assign tasks really counts as AI.

somewhat dystopian example of a future workplace, *The Verge* recently uncovered Amazon’s widespread use of algorithms to manage warnings and terminations of employment relationships.⁶ The website published a letter written by Amazon’s attorney, stating that ‘Amazon’s system tracks the rates of each individual associate’s productivity, and automatically generates any warnings or terminations regarding quality or productivity without input from supervisors.’ Addressing a legal complaint of unfair dismissal, Amazon’s attorney argues that ‘the system, not the (redacted) supervisor, monitors and generates any productivity related notices’. This suggests that algorithms may weaken employees’ ability to argue against dismissals due to an illicit pretext.

Algorithmic management is creeping into companies through the generation of new mobile applications. Several managers I interviewed recounted how their companies initially adopted new mobile applications to coordinate front-line work and provide systematic performance feedback, but ended up shrinking the number of traditional supervisors. Big retail and restaurant chains have adopted staff scheduling software provided by companies such as Kronos. These systems optimize the required workforce based on real-time factors such as weather and the arrival of delivery trucks, creating costs savings for corporations. However, the employer-side flexibility reduces the predictability that employees have about the timing and frequency of their work shifts, worsening the situation of low-paid workers who are often already in a vulnerable position.⁷

Over time, companies can eliminate a whole layer of supervisors in their hierarchy by relying more heavily on algorithmic management to track performance and provide feedback. Greg Tanaka, the founder and CEO of US-based technology company Percolata elaborated on their service in the *Financial Times*:

What’s ironic is we’re not automating the sales associates’ jobs per se, but we’re automating the manager’s job, and [our algorithm] can actually do it better than them.

The data imperative and algorithmic management

The pervasiveness of real-time data is motivating companies to adopt algorithmic management practices. As soon as corporations are able to gather data on how tasks are carried out by their employees or subcontractors, they have an opportunity to devise algorithms to optimize them. And as soon software systems are able to monitor and control employees, the logic of optimization calls for the elimination of unnecessary human supervisors as obvious and rational step towards more cost-effective processes.

Percolata provides an example of an advanced algorithmic management system delivered as a cloud-based service to the specialty retail sector. Its system aims to replace sales managers with algorithms and mobile apps. The system schedules shifts for workers, but goes beyond simple staffing by using data to evaluate the performance of different sales clerks. The software uses sensors to track the number of visitors to the store, and scores the performance of sales clerks based on the sales they generate per visitor. The system takes into account a number of variables, such as the specific site and time of day. It then

⁶ Lecher (2019, 25 April).

⁷ Kanter (2014, 13 August).

optimizes work schedules, pairing sales personnel who appear to work well together and taking into account whether a person performs better in the mornings or evenings. The company has run comparison tests at similar store locations, and claims that adopting the system could lead to a 30% increase in sales.

Percolata's system illustrates three common aspects of algorithmically managed workers that are connected to the data imperative:

- (i) Following the data imperative, the system requires the collection of data about the relevant business process that is as rich and varied as possible. The greater the number of variables, the more powerful predictive algorithms the company can develop. Percolata turns the staffing of stores into one additional process of optimization that requires maximal monitoring of all aspects of employees and their performance.
- (ii) The system automatically optimizes activities with minimum human effort, facilitated by clever self-service design. Percolata's system interacts directly with sales associates via a mobile app. CEO Tanaka suggests that their software is making traditional store managers obsolete.
- (iii) Optimizing is done at maximum scale by moving the control of business processes to specialized companies. Percolata offers to take over the staff scheduling processes from any retailer. This division of labour allows retailers to focus on running processes in which they have greater competencies, while providing sufficient scale and resources for specialist companies such as Percolata to invest in developing the efficiency of the optimizing service further.

Given the potential cost savings and promises of increased sales, there are strong incentives for specialty retailers to embrace the data imperative by adopting the services Percolata and its many competitors provide. As firms gather more real-time data, they are able to construct virtual representations of their customers, workers, and business processes. The logic of optimization implies the use of such data to improve companies' competitiveness.

In studying data-driven companies in the service sector, my general techno-optimism has often been complemented with bouts of significant techno-pessimism. If this really is the future of work, things certainly do not seem to be improving for the employees. Algorithmic management can be cruel. The *Financial Times* reported that, in companies using Percolata's software, higher performance is usually 'rewarded' with more working hours. In other words, a clerk who fails to sell enough products to the average store visitor can see their working hours cut. Over the years of our working careers, many of us may have occasionally felt that our bosses lacked empathy. With algorithmic management, the good news is that the level of empathy is constant and predictable. The bad news is that there won't be any.

The nefarious dynamics of job impoverishment

Algorithmic management is generally associated with simple, low-paid tasks. This is not a coincidence. Relatively simple tasks with predictable outcomes are easier to control by and optimize with algorithms. However, this does not mean occupations involving complex tasks will be safe. Organizations adopting algorithmic management have strong

and compelling reasons to actively reduce the complexity of employee tasks. I argue that the data imperative intrinsically calls for ‘job impoverishment’.

In 1968, the American psychologist Frederick Herzberg introduced the concept of ‘job enrichment’ to the management jargon. He advocated the design of more complex, meaningful, and motivating jobs. The efforts were not marketed as corporate social responsibility but, rather, as a means to improve productivity. Management researchers had previously found that the Fordist conception of a production line had reduced work to such an elementary level that workers had trouble concentrating. Offering the workers more interesting and meaningful jobs would provide motivation and thereby improve their productivity. While job enrichment itself has fallen out of favour during recent decades, it has lived on in the ideas of organizational empowerment and, recently, in the concept of self-organizing.⁸

Despite the obvious benefits various iterations of job enrichment have had in increasing employee motivation and initiative, reducing turnover, and improving collaboration, corporations do not appear to be greatly concerned about job enrichment for the algorithmically controlled roles. I could not find any evidence that Uber or Deliveroo had done anything to increase the complexity of their jobs. Actually, everything suggests the opposite to be the case. As corporations follow the data imperative to implement algorithmic management, they have four economic reasons to embrace ‘job impoverishment’; that is, designing jobs with minimal complexity.

First, the lower the complexity of a task, the easier it is to control the workers. The simpler the tasks are that workers carry out, in general, the less variance there is in their conduct and the more easily their outputs can be measured and compared. These characteristics support the design of algorithms to effectively control the workers, as the predictability of business processes increases. Conversely, the more complex the expertise of the human workers, the more varied their performance and outputs are likely to be. From the algorithmic design perspective, unpredictable variance hampers data-driven optimization and creates inefficiencies. The fewer choices the workers can make, the more optimally the information system can ‘use’ them. For example, if Uber or Deliveroo could eliminate the ability of their drivers to reject gigs, their algorithm could assign drivers more efficiently to specific clients.

Second, lower complexity allows workers to be recruited more quickly into the system if demand expands. Digital businesses often aim for rapid increase in their scale and global reach so as to justify risky investments in technology and business development. The more complex the tasks controlled by algorithms, the more challenging it would be for a company to expand internationally, or to ramp up its services if demand increases. As venture capital funding is commonly premised on the ability of firms to scale up their activities rapidly, new technology firms face pressures to design their processes to use workers with impoverished tasks.

Third, and relatedly, a lower complexity of jobs improves a firm’s bargaining power over labour. Information systems incur low costs once they have been designed. When a company uses algorithmic management on a significant scale, the salaries of workers can

⁸ The concepts of self-management and self-organization in radically non-hierarchical organizations promoted by Laloux (2014) represent the newest and more thorough iteration of job enrichment.

easily become the defining part of its cost competitiveness. For example, Uber pays 60–75% of its service fees to its drivers. By deliberately working to lower the demands of their jobs, companies can increase the pool of potential employees. This translates directly to lower bargaining power and compensation for the workers.

Fourth, many corporations are looking to replace human workers altogether with smart robots and AI. Uber has explicitly committed to developing self-driving cars, while Amazon is investing heavily to replace ‘artificial artificial intelligence’ with the real thing. The simpler the tasks that humans undertake, the easier it will be eventually to replace them with robots or smart algorithms. Thus, the natural instinct of data-driven companies is to design the work roles under algorithmic management to be as limited in scope as possible.

The deliberate design of impoverished tasks not only minimizes the required skills, it also diminishes opportunities for meaningful learning. When algorithms handle the bulk of decisions and coordination tasks related to a job, the range of skills that workers can learn in their job is curtailed. Take Uber, for example. While traditional taxi drivers have shared knowledge of the best spots to pick up customers and the fastest routes, Uber drivers have limited ability to determine where to pick up customers, or which route to drive. While Uber drivers can certainly learn and improve in their jobs, particularly in interacting with their customers, their learning opportunities are narrower than those of traditional taxi drivers.

One may ponder whether the life of taxi drivers was really better when they had to learn the best routes and the best places to find clients. I would argue that learning is intrinsically valuable beyond the content of what is learned; the process of learning and improving provides meaningfulness and satisfaction. When a worker has very limited or no opportunities for learning, they are more likely to feel that they are in a meaningless grind, a dead-end job with no meaningful change in sight. The inability of workers to control their own work harks back to factory work in the era of industrialization. Algorithmic management seems to be bringing back some of the worst aspects of Taylorism (see Information Box 3.1 in Ch. 3).

The upwards creep of algorithmic management: the future of software-controlled professionals?

The limited ability of algorithmic management to handle the optimization of complex tasks would seem to restrict its applicability to workers with a limited education. Unfortunately, this would be a false conclusion. Complexity, as it appears to the design of a system, relates to variability in inputs and outputs, rather than the internal sophistication of executing the task. After all, driving a car is a fairly sophisticated skill. Yet, from the perspective of system design, instructing a driver to drive from point A to point B is a very simple and predictable task with limited interactions with other processes. Similarly, algorithms can easily manage other knowledge-intensive tasks when they have limited interactions with other processes. Indeed, several companies have already applied algorithmic management practices to language translators. In the future, even teachers, accountants, and lawyers may find themselves being managed solely by a computer system.

Language translators provide an example of skilled work that is already falling under algorithmic management. While this group of experts is already under threat from AI, there still remains a need for professionals to produce accurate and readable translations. The start-up company Transfluent is one among many that have developed a platform with algorithmic management practices for translation services. Instead of a mobile app, they still operate at the more leisurely pace of the industry. Their system emails potential jobs to translators, who accept them by responding to the IT system via email. Thousands of professional translators from around the world work through the Transfluent web app, translating documents and localizing software applications for customers they will never meet. The translation work is priced based on a flat per word basis. The company promises to provide rapid translation on any scale, sourcing the work to a large network of native translators around the world.

Moving up in the pay scale, lawyers seem unlikely to remain entirely safe from these developments either. Lawtova is one of the many gig platforms looking to become the ‘Uber of law’. They offer lawyers with a steady flow of work and well-designed online tools, while consumers are promised affordable high-quality law services via an app. Despite the far greater price point than ride-hailing services, the basic logic of algorithmic management remains: a computer system replaces human managers in assigning tasks and monitoring their completion.

The upwards expansion of algorithmic management requires further management innovations that help digitally represent professional tasks and their outcomes. Evaluating a lawyer is clearly not as easily done as evaluating an Uber driver. Customers may often have little or no idea of the quality of the service these professionals provide, making the 5-star rating system used by Uber inappropriate. But accreditations, peer assessments, and outcome-based metrics may well make these established industries susceptible to algorithmic management. To the extent that such jobs entail specialized skills, algorithmically managed professionals will have a very different profile and status from the current gig workers.

Building better algorithmic management

The problems of algorithmic management are many, as I have catalogued, and it appears to create a further fault line between management and the algorithmically controlled employees. New work roles often suffer from perceived unfairness and a lack of empathy, and their broader adoption seems likely to create dead-end jobs with limited prospects for learning and personal development. While Toyota’s management systems were explicitly designed to maximize creative inputs and innovation from front-line workers, the gig economy hardly encourages such behaviour. Established examples of algorithmic management, such as Uber, are hardly beacons of the humane workplace. At the extreme, such problems could attract negative attention from government regulators and labour unions, and even trigger consumer boycotts. Yet, algorithmic management is also a fairly recent innovation and there is hope for its reformation.

Algorithmic management need not be as bad as it is currently in most of its incarnations. While most algorithmic management systems have been designed purely to optimize central business processes, the data imperative can also drive gradual improvements for the employees. Optimizing the employee experience is not contradictory to optimizing

the economics of business processes. In fact, there are strong economic reasons to improve the design of algorithmic management to improve the well-being of workers. More satisfied employees lead to lower recruitment costs, reduced employee churn, and greater support from government, labour unions, and public opinion.

Investing in the design of the algorithms and mobile interfaces for managing contractors and employees can provide an advantage on the labour market. The domain of software engineering known as ‘affective computing’, and the related strand in usability research known as ‘affective design’, study ways in which computer systems can detect, accommodate, and induce human emotions. While this may sound manipulative, it has genuine power to improve the well-being of workers. Inducing a sense of belonging and identification with the company, creating virtual communities, and illuminating the positive impact workers have on their customers can provide motivation. It seems likely that spending a fraction of the money that is being invested in the design of consumer-facing interfaces to design employee experience could significantly improve algorithmic management.

Companies adopting algorithmic management practices should consider three key changes that help improve the role of algorithmically controlled workers. These issues have been highlighted repeatedly in my own interviews, popular writing, and nascent academic research.

Make the system fair and transparent

Algorithmic management systems are going through ongoing development, and it may not be surprising that Deliveroo and Uber have been reluctant to commit to specific mechanisms. Yet, Akseli is not unique in lamenting the lack of transparency he perceived while working for Deliveroo. Academic research has highlighted the perceived lack of unpredictability in the operations of Uber and other crowdsourcing platforms that creates a sense of unfairness.⁹

To tackle fairness, dividing it into three complementary perspectives is helpful: distributive, procedural, and interactional justice.¹⁰ Distributive justice relates to outcomes and whether they appear appropriate. For example, drivers have criticized Uber for discrepancies they perceive between bonus payments and their efforts.¹¹ Procedural justice captures whether workers will conceive the system to operate with acceptable principles and procedures. As algorithmic management systems tend to lack transparency, it is no surprise they are perceived as unfair. How can you trust a system to treat you fairly when you cannot understand how it decides your tasks and measures your performance? Finally, interactional justice captures whether the employee is treated appropriately, including with regard to dignity and respect in interactions, and the provision of relevant information. While interactions in organizations have been conceived to take place among humans, algorithms can also vary in their ‘respectfulness’. For example, the ability of Deliveroo and Uber drivers to reject or ignore jobs that they do not want to take is a small but important way for algorithms to ‘show’ respect.

⁹ Lee *et al.* (2015).

¹⁰ The most concise treatment of the phenomenon is provided by Cropanzano *et al.* (2007).

¹¹ McFarlin and Sweeney (1992) show that both distributive justice and procedural justice are important goals.

Perceived justice is easily compromised when management tasks are implemented through algorithms. A co-founder of a food delivery start-up elaborated to me on how a dedicated human ‘flight controller’ distributing jobs to couriers tried to maintain a sense of fairness even when trips of varying length are all associated with the same bonus payment. Now that the company is designing an algorithm to replace the employee, discrepancies between the effort required and payment have become much more pronounced. The company could respond by modelling the expected duration of trips and base its bonuses on the ability of the couriers to run deliveries on time.

Improve safety and provide care

Information technology now allows the benign monitoring of workers. One of the best examples is the GPS tracking devices in trucks that prevent their drivers from exceeding speed limits or legally mandated working hours. Unfortunately, most algorithmic management systems have failed to incorporate such functionality. For example, the excessively long working hours of Uber drivers have been linked to fatal traffic accidents.¹² It is fairly easy to implement a monitoring and enforcement system that limits the ability of contractors to work dangerously long hours, should the company consider it a priority.

The replacement of supervisors with information systems and mobile apps should not absolve corporations from their responsibilities for the well-being of their employees. While algorithmic management has come to mean reduced attention and care towards employees, this need not be the case. Mobile apps and devices could easily monitor the emotional and physical conditions of workers, and algorithms could be designed to implement useful interventions. The data-driven technologies and practices of can help scale up preventive health care interventions for employees and reduce costs. Showing that a company cares about its employees can also increase their commitment and loyalty.

Build digital communities

Many leading digital companies are masters at building communities. Curiously, the pioneers of algorithmic management and the gig economy have largely failed to develop positive communities. As a consequence, workers have formed unofficial groups on platforms such as Facebook and Reddit. Community building may not directly help to increase efficiency. Since algorithmically managed work roles are often very simple by design, the knowledge sharing typically associated with communities may remain limited. However, a network of social ties can constitute a positive sense of community that provides other intangible benefits to workers, increasing their commitment and reducing workforce turnover.¹³

¹² *US Today* reported that some Uber drivers work shifts of 20 hours or more, greatly increasing the danger of fatal traffic accidents. The company finally addressed these issues in 2019. <https://www.usatoday.com/story/money/cars/2017/07/10/some-uber-drivers-work-dangerously-long-shifts/103090682/>

¹³ Soltis *et al.* (2013) found that employees who were supported at work by individuals who had no explicit obligation to do so became less likely to consider quitting their jobs.

Research on precarious work relationships has generally found that social networks provide a significant source of stability that help individuals cope with unpredictability.¹⁴ Sociological research suggests that lack of predictable employment leads to negative physical and mental health outcomes and increases the risk of divorce and poverty.¹⁵ As a society, we may have been too willing to accept that work is simply unpredictable and to delegate the responsibility for managing these uncertainties to the individuals when corporations could do much more.

By addressing these three shortcomings, executives may be able to significantly improve the competitiveness of their companies in the labour market, and to protect themselves from protests and questions from consumers, government regulators, and labour unions.

The future of work needs to be designed

Algorithmic management practices are a direct consequence of the central norms of the data imperative. When work is seen in terms of business processes subject to optimization, data imperative calls managers to engage in the systematic leveraging of real-time data and smart algorithms to optimize the use of the workforce; not to do so would be negligent. I predict that algorithmic management will grow more common in the near future, even if the ability of artificial intelligence and advanced robots to replace human workers completely remains a long-term goal.

Yet, the future role of algorithmic management in society and its impact on the career paths of individuals remain shrouded in uncertainty. Algorithmic management does not have to be a blind force of nature that inevitably leads to the dehumanization of workers. It poses questions for corporations they need to address. There is real potential for algorithmic management to free up workers by increasing their flexibility: signing up for work in the morning via a mobile app enables workers to decide when they work, how long they work, and where they work. Corporations can use algorithmic management practices to improve the motivation and commitment of their permanent workforce by providing greater choice in tasks employees engage in and flexibility in their schedules.

Moreover, algorithmic management does not actually require companies to monitor how their employees conduct their work, as long as the work outcomes can be captured in data. In fact, research shows that monitoring by supervisors that focuses on *how* work is done, rather than the outputs, can substantially reduce productivity. Professor Ethan Bernstein found that employee efforts to hide their private behaviours from supervisors can often have a greater negative effect than the behaviours that were supposed to be prevented by monitoring.¹⁶ Moreover, when Bernstein ran an experiment that modestly improved the privacy given to employees in a factory, the productivity increased. Freed from constant oversight, employees began cutting corners to save time ('productive deviance') and ran more local experiments that led to productivity improvements. By ignoring employee inputs—that is, what they do, and focusing instead on the outputs—that is, what they accomplish, algorithmic management practices can increase employee freedom in a way that unleashes creativity and improves motivation.

¹⁴ Petriglieri *et al.* (2019).

¹⁵ Kalleberg *et al.* (2000) and Inanc (2018).

¹⁶ Bernstein (2012).

I believe the coming decade will be pivotal in plotting the course for corporate employment and work roles. Algorithmic management can lead to the impoverishment of jobs, precarious employment relationships, and the re-emergence of an ‘underclass.’ To avoid this, governmentst and enlightened business leaders need to push corporations to leverage data and algorithms to create more meaningful and predictable jobs and work communities for everyone.