Indigenous Employment Futures in an Automated Mining Industry

An Issues Paper and A Case for Research

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Contents

1 Introduction

This paper discusses the implications of mine automation for Indigenous peoples.[1] Rapid advancements in new mining technologies, such as mine automation, have the potential to impact Indigenous peoples and the Indigenous mining workforce. In the past two decades, data confirms that in some jurisdictions, Indigenous peoples' participation in mining employment has grown significantly. In Australia and Canada, the number of Indigenous employees is unprecedented. The predicted acceleration in mine automation could disrupt this positive trend. There is no indication that the industry is considering the potential downside effects of mine automation on this stakeholder group. A careful and critical examination of mine automation in the global mining industry and its effects on Indigenous peoples is urgently required.

The greatest losses in Indigenous mining employment are likely to be experienced in countries where the greatest gains have been made. For instance, Indigenous jobs in Australia and Canada may be more at risk than in other locations. In these two countries, secondary data on Indigenous mining employment is available through the national census, to some degree enabling the monitoring of shifts in Indigenous mining employment. Impacts in other jurisdictions will be more difficult to detect, principally because of limited access to reliable census data, and complex issues of marginality and exclusion. That is, in many of these jurisdictions, Indigenous peoples' access to the formal economy, including mining employment and business opportunities, is yet to be realised, or there may be other livelihood priorities. The impacts of mine automation on excluded groups will be far more difficult to detect.

At this stage, it is major mining companies who are most likely to induce Indigenous job losses, and who are reputationally exposed as a consequence. These companies include members of the International Council on Mining and Metals (ICMM), the Minerals Council of Australia (MCA) and the Minerals Association of Canada (MAC). Aside from leading the technological transformation, these companies have the most developed set of social performance standards, and the most comprehensive suite of binding agreements with Indigenous groups. Mining companies that have publicly committed to "respect" human rights, including the rights of Indigenous peoples, cannot afford to overlook impacts on Indigenous peoples and the Indigenous workforce.[2]

> In Australia and Canada, the number of Indigenous employees is unprecedented. The predicted acceleration in mine automation could disrupt this positive trend.

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[1] In many less developed states in Africa and Asia it is not a straightforward task to identify Indigenous peoples. See Sawyer S., Gomez E.T. 2012. "On Indigenous Identity and Language of Rights". In Sawyer S., Gomez E.T. (eds) *The Politics of Resource Extraction.* International Political Economy Series. Palgrave Macmillan, London
For the purposes of this discussion paper, we broadly include minority groups with Indigenous and tribal peoples. This is because significant numbers of minority groups are also subject to marginalisation, unemployment, lack of mainstream education and other social vulnerabilities. As a result, many of the issues we raise in this paper are transferable to other minority or marginalised groups.
[2] This suite of commitments typically includes recognition of or policy alignment with the UN Guiding Principles on Business and Human Rights (2011), the IFC Performance Standards (2012) and the UN Sustainable Development Goals (2015).

The global Indigenous rights agenda was legitimised and consolidated in 2007 with the adoption of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) by a significant majority of member states. Recent data about the global Indigenous estate indicates that Indigenous peoples have land tenure or management rights over one-quarter of the earth's land mass.[3] Across this estate, mining companies have negotiated land use and other types of local-level agreements with Indigenous, tribal and minority groups. Agreement provisions that enable access to training, employment and local business opportunities are a common inclusion.[4] What is not common are provisions that consider and account for the potential decline of local-level employment through the increased use of technology. Though the number of Indigenous employees may be small relative to the total workforce base, efforts by the industry to enable Indigenous employment have been substantial, driven by local community expectations that mining companies provide employment, training and local business opportunities.

The UN's Sustainable Development Goals (SDGs) have, since 2015, actively sought to engage the private sector. Many major mining companies have committed to the supporting the SDGs, and the mining industry has been at the forefront of embedding the SDGs in their sustainability strategies, with a growing collection of resources to assist in operationalising these commitments.[5] Among other goals, the SDGs promote the "inclusive and sustainable economic growth and employment and decent work for all". A report by the Aboriginal Economic Development Board of Canada reminds us that "employment is the cornerstone for economic development and, in addition to being the main source of income for most individuals, is a basis for self-respect and autonomy".[6] This SDG poses a particular challenge given the commitments that global mining companies have made to Indigenous peoples, and the likely automation of jobs that currently support the economic participation for those same peoples.

The challenge of ensuring responsible business in a rapidly changing world is not new. In 1999, at a World Economic Forum, then UN General Secretary Kofi Annan stated: "I propose that you, the business leaders... and we, the United Nations, initiate a global compact of shared values and principles, which will give a human face to the global market."[7] In the context of mine automation, we ask: what are the implications for the sector, and for

Recent data about the global Indigenous estate indicates that Indigenous peoples have land tenure or management rights over one-quarter of the earth's land mass.

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[3] This represents at least ~38 million square kilometres in 87 countries or politically distinct areas on all inhabited continents Garnett, S et al 2018. "A spatial overview of the global importance of Indigenous lands for conservation". In Nature Sustainability Vol 1 July 2018 Pp 369–374.

[4] O'Faircheallaigh, C. 2010. 'Aboriginal-Mining Company Contractual Agreements in Australia and Canada: Implications for Political Autonomy and Community Development' *Canadian Journal of Development Studies* 30:1-2, Pp 69-86.

[5] See for instance *Mapping Mining to the Sustainable Development Goals: An Atlas.* 2016. Available at http://unsdsn.org/resources/publications/mapping-mining-to-the-sustainable-development-goals-an-atlas/.

[6] Canadian Government. 2013. *Aboriginal Economic Benchmarking Report. Core Indicator 1 Employment.* The National Aboriginal Economic Development Board. June 2013. Available at http://www.naedb-cndea.com/reports/benchmarking-core-indicator-1-employment.pdf

[7] United Nations Global Compact. 2017. "Making Global Goals Local Business". Available at https://www.unglobalcompact.org/sdgs.

Indigenous and minority peoples, as this human face becomes increasingly robotic?

There appears to have been limited investment in research about Indigenous mining employment in recent years. As the industry shows signs of improvement, and invests in building cost efficient and high-technology mines, it is imperative that companies also invest in understanding how automation will impact Indigenous employees, their communities and suppliers in each of their operating contexts. This would require a commitment to long-term, independent, empirical research, and sustained engagement with Indigenous peoples about their economic empowerment. In this paper, we provide a brief overview of mining's technological transformation. We then outline key issues for consideration, and an agenda for future research on Indigenous employment futures in an increasingly automated mining industry.

2 Mining's technological transformation

The global mining sector, like other sectors of industrialised economies, is undergoing a technological transformation as part of what some commentators refer to as the "Fourth Industrial Revolution".[8] New technologies are transforming the nature of mining and industrial work. A recent *Global Prediction Report* on the "Near Future of Mining" suggests that by 2020 "robots will replace more than 50 percent of miners".[9] This could equate to the potential loss of about 330,000 jobs, or nearly five percent of the global workforce, over the next decade as a consequence of increased digitalisation.[10]

Significant innovations are currently being rolled out across the industry, and include replacing human operators with autonomous trucks, and shifting control centres to capital cities and regional centres, far removed from where mining takes place. In Australia, several of BHP's central Queensland coal mines are now operated through integrated remote operations centres based 800 kilometres away in Brisbane. These centres oversee the remote haul trucks and dig units in some of the state's largest and most productive mines. Meanwhile, Rio Tinto has developed the world's first long distance heavy haul driverless trains in Western Australia's Pilbara region to service their iron ore mines. Also in the Pilbara, Rio Tinto has approved funding for its Koodaideri mine as the "first intelligent mine, incorporating the latest in high-tech advances in the

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[8] This term has been used by the founder of the World Economic Forum, Klaus Schwab.
[9] BDO 2018. "Robots to replace 50% of miners by 2020: BDO Global Prediction." Available at https://www.bdo.com.au/en-au/news/media-releases/robots-to-replace-50percent-of-miners-by-2020. Note that while this is a global prediction, it seems to us that it is most applicable to developed countries.
[10] World Economic Forum. 2017. *Digital transformation Initiative: Mining and Metals Industry*. Available at http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/wef-dti-mining-and-metals-white-paper.pdf.

industry and utilising an increased level of automation and robotics". [11] The 'mine of the future', it seems, has already arrived.[12]

Other mines are incorporating similar technologies, including robotic mining with semi-autonomous crushers, rock breakers and shovel swings, autonomous drilling and tunnel boring systems with highly agile "snake robots" and automated long-wall plough and shearers. The language used in this new field is "remote monitoring, modelling and optimising, future probabilities and smart algorithms".[13] Industry analysts describe mine automation as a "game changer" and surveys suggest that automated haulage vehicles will be the top technology to impact the commodities market in the coming year.[14]

Earlier this year, former Head of Innovation at Rio Tinto, John McGagh, observed that "the industry is larger than ever, product demand is high, and growth has slowed. Management focus has swung from capital expansion to internal productivity".[15] This swing has ushered in the rapid introduction of new technologies. Major companies, with their significant research and development capability, are leading the industry's technological transformation. Mid-tier and junior companies are likely to follow as technologies are proven up, and capital costs decline. The mining industry's narrative is overwhelmingly positive about the potential for new technologies to reduce labour and operating costs, to improve operational efficiency, deliver environmental benefits and to foster a safer working environment in a tighter market. These same companies are largely silent on the downside risks that these new technologies may pose for local employees and communities.[16]

The speed with which these new technologies are changing society has become the focus of national human rights bodies, such as the Australian Human Rights Commission (AHRC), that has launched a major project called *Human Rights and Technology*.[17] As the AHRC states, "the project will create a blueprint for responsible and inclusive innovation and give Australian governments a framework to protect our rights and freedoms in

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[11] See Rio Tinto Media Release. 2018. "Rio Tinto approves initial funding for its first intelligent mine in the Pilbara". 1 August 2018. Available at http://www.riotinto.com/documents/180801_Rio_Tinto_approves_initial_funding_for_its_first_intelligent_mine_in_the_Pilbara.pdf.

[12] "Rio Tinto preparing for the Mine of the Future with automation". Feb 26, 2018. Available at https://www.zdnet.com/article/rio-tinto-preparing-for-the-mine-of-the-future-with-automation/.

[13] McGagh, J. 2018. "Vignette: The Need for Innovation in Mining and the Potential Areas for Adopting New Technologies". In [eds] M.J Clifford *et al Extracting Innovations: Mining, Energy and Technological Change in the Digital Age*. Taylor and Francis.

[14] Newport Consulting 2018. *Mining Business Outlook Report*. Available at http://newportconsulting.com.au/2018-mining-business-outlook-industry-stages-strong-comeback/.

[15] McGagh, J. 2018. "Vignette: The Need for Innovation in Mining and the Potential Areas for Adopting New Technologies". In [eds] M.J Clifford *et al Extracting Innovations: Mining, Energy and Technological Change in the Digital Age*. Taylor and Francis.

[16] Keenan, J., Kemp, D. and J.R. Owen (under review). The social risk of new mining technologies, *Journal of Cleaner Production*.

[17] The AHRC has launched a project that will seek to ensure human rights are prioritised in the design and regulation of new technologies. Available at https://www.humanrights.gov.au/news/stories/major-project-focus-human-rights-and-technology.

the digital age". Globally, civil society groups and worker organisations have been exploring the social, ethical, and human rights implications of data-driven technologies.[18] In May 2018, a coalition of human rights organisations and technology groups signed the Toronto Declaration, calling on governments and technology companies to ensure that machine learning systems do not undermine equality and the right to non-discrimination.[19]

The shift to high technology and data science and away from "pick and shovel" mining will drive demand for highly skilled workers. This shift could yield a greater inequality in the mining labour market. The potential of "job polarisation" on a global level and within specific industries is a significant concern. Recent books with titles such as *Humans Need Not Apply* by Jerry Kaplan[20] and *Rise of the Robots* by Martin Ford[21] speak to a broader shift toward technology and the uncertainties it brings. What determines job exposure to automation is whether the work is routine and repetitious, rather than whether it is manual or white- or blue-collar.[22]

The technological transformation in the mining industry corresponds with improved prospects for mining sector investment and growth. With readily accessible mineral deposits largely exhausted, more remote and previously inaccessible orebodies are being pursued through the application of new technologies. Accessing previously inaccessible orebodies is a critical driver of the industry's current technological transformation. The remote location of many of these orebodies will increase the industry's engagement with Indigenous peoples and other vulnerable populations. How this engagement should occur will become an increasingly relevant question for the industry and for societies globally.

3 Issues for Indigenous peoples

In light of the shift to remote operations and mine automation, questions about "the future of work" have particular implications for Indigenous and minority peoples. There is of course a spectrum of engagement between Indigenous peoples and industry – not all Indigenous groups that engage with the sector seek employment, and not all groups wish to engage. Some groups will prefer to remain isolated from mining and other industrial scale

> Globally, civil society groups and worker organisations have been exploring the social, ethical, and human rights implications of data-driven technologies.

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[18] Dunstan, A.H and Hodge, M. 2018. "Artificial Intelligence: A Rights-Based Blueprint for Business," BSR, San Francisco.

[19] This Declaration was developed at the annual global conference "RightsCon" that has been held annually since 2011 (first conference in Silicon Valley USA), with a focus on human rights in the digital age. Available at https://www.accessnow.org/the-toronto-declaration-protecting-the-rights-to-equality-and-non-discrimination-in-machine-learning-systems/.

[20] Kaplan, Jerry. 2015. *Humans Need Not Apply: A Guide to Wealth and Work in the Age of Artificial Intelligence*. New Haven: Yale University Press. Basic Books.

[21] Ford, Martin. 2015. *Rise of the Robots: Technology and the Threat of a Jobless Future*. New York: Basic Books.

[22] The Economist. 2016. "Impact on Jobs: Automation and Anxiety". 2016. June 25. https://www.economist.com/special-report/2016/06/25/automation-and-anxiety.

development. While recognising these variations, there are a number of intersecting issues that we consider.

These are:

- mining and Indigenous employment
- local-level agreements
- state regulatory requirements
- mining company policies and commitments.

3.1   Mining and Indigenous employment [23]

3.1.1   Employment in remote regions

In both Australia and Canada, mining activity is often located on or adjacent to the lands of Indigenous peoples. In these and other remote regions with large-scale mines, primary and secondary mining employment is often the only avenue for Indigenous peoples to engage with the market economy. While employment data is discoverable, it can be difficult to access, even in Australia and Canada. For countries in Africa, Asia and in Latin America, it can be even less straightforward, as the collection of census data can be irregular and unreliable. For this reason, we draw primarily on data from Canada and Australia in the discussion that follows.[24]

Unemployment trends amongst the Indigenous population in Canada and Australia are remarkably similar at the national level, and with distinct and comparable demographic profiles for remote Indigenous populations.[25] Across Australia, approximately 47 percent of the Indigenous working age population is employed, compared with 72 percent of the non-Indigenous working age population, representing a gap of 25 percent.[26] Likewise, Statistics Canada reported that 48 percent of the Indigenous working age population was employed, compared to 63 percent of non-Indigenous people, representing a gap of 15 percentage points.[27]

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[23] In this section we use First Nations interchangeably with Indigenous, as this is the preferred term used in the Canadian context. It is also becoming a preferred referent for Australian Indigenous peoples.

[24] We note the limitations of this review as it focuses on English language reference materials.

[25] Likewise, Australia and Canada have similar demographic profiles in their Indigenous populations – which are far more youthful and growing than non-Indigenous profiles. For instance in Canada, in 2011, 46% of the Indigenous population was under age 25 compared with 29% for the non-Indigenous population. The median age of the Indigenous population was 28 compared with 41 for the non-Indigenous population in 2011. The number of working age (25 to 64) Indigenous people increased 21% between 2006 and 2011 compared with only 5% growth among the non-Indigenous population (Reconciliation Canada: Growing Canada's Economy by 27.7 million. Prepared for: The National Aboriginal Economic Development Board By: Fiscal Realities Economists. Available at http://naedb-cndea.com/reports/naedb_report_reconciliation_27_7_billion.pdf.)

[26] Venn, D. and Biddle, N. 2018. "Employment Outcomes: 2016 census papers". Centre for Aboriginal Economic Policy Research, ANU, Canberra. Available at http://caepr.cass.anu.edu.au/sites/default/files/docs/2018/6/CAEPR_Census_Paper_5_2018_0.pdf.

[27] Canadian Government. 2013. *Aboriginal Economic Benchmarking Report. Core Indicator 1 Employment.* The National Aboriginal Economic Development Board. June 2013.
Note that this report draws on census data from 2006, while the Australian employment data is from the 2016 census.

In both countries, employment rates are consistently lower in remote and very remote areas. In Australia, for instance, the Indigenous employment rate in remote and very remote regions is 36 percent, with 64 percent of the working age population unemployed.[28] In the Northwest Territories of Canada, 53 percent of the Indigenous working age population was employed, compared to 81 percent for non-Indigenous persons. This 30 percent gap has not shifted for the past 10 years.[29]

A focus on remote regions is critical, as this is where states struggle to deliver services and address social problems, and where the vast majority of large-scale extractive industries projects are located. In Australia, between 2011 and 2016, the mining sector emerged as the most significant employer of Indigenous men in remote areas, at 18 percent of their total employment.[30] Specifically mining employed 4,275 men in remote regions.[31] The data indicates that in remote areas, mining employment has, for the first time, exceeded employment in public administration (referring to local council services) for Indigenous men.[32] Remarkably, the mining sector did not reduce the number of Indigenous employees in the last mining sector slow-down, whereas the number of non-Indigenous employees declined.

Relative to other industries, the Canadian mining industry has also been successful in reducing unemployment rates for Indigenous peoples in remote regions. In Canada, Indigenous peoples comprise six percent of the mining industry workforce compared to four percent in other industries. Kim Rudd, Parliamentary Secretary to the Minister of Natural Resources Canada, stated that mining is the largest employer of First Nations in Canada, employing 11,000 Indigenous people.[33]

While these gains are commendable, we argue that these jobs may be at risk as mine automation occurs in remote regions. One reason is because

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[28] The Australian Bureau of Statistics, National Aboriginal and Torres Strait Islander Social Survey, 2014-15 Available at http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4714.0~2014-15~Main%20Features~Labour%20force%20characteristics~6.

[29] "Stats show glaring gap between Indigenous and non-Indigenous employment rates in the North West Territories. 2017. Available at https://www.cbc.ca/news/canada/north/indigenous-employment-statistics-canada-nwt-1.3942204 and see
Canadian Government. 2016. Aboriginal Economic Development Board. *Reconciliation: Growing Canada's Economy by 27.7 Billion: Background and Methods Paper.* Available at http://naedb-cndea.com/reports/naedb_report_reconciliation_27_7_billion.pdf.

[30] Venn, D. and Biddle, N. 2018. "Employment Outcomes: 2016 census papers". Centre for Aboriginal Economic Policy Research, ANU, Canberra.

[31] See Venn and Biddle 2018:13. Note that this Australian figure does not include those who work in secondary services and nor Indigenous women who work in the sector.

[32] This data is indicative but should be interpreted with caution. This is notably the case with the employment categories, which are not adequately specific. For instance "mining' may not include secondary services, while the sparse population means that the data is highly aggregated.

[33] Mining.Com. 2018. "Major Mines Increasingly Tapping Canadian Indigenous Labour Force". Jan 31, 2018. Available at http://www.mining.com/web/major-mines-increasingly-tapping-canadian-indigenous-labour-force/.
see also, Natural Resources Canada. 2016. *Minerals Sector Employment Information Bulletin 2016*. Available at http://www.nrcan.gc.ca/mining-materials/publications/16739.

in Australia and Canada, the cost of labour is high, and automation will bring significant cost-savings.[34]

3.1.2 Indigenous mining employment in transition?

Mining proponents readily point to evidence that the industry generates local benefits that exceed the local costs and, of these benefits, local employment is the most readily available. When it occurs, local employment is certainly a visible and tangible benefit. Primary and secondary employment data speak to the utility of quantification-based arguments. To understand Indigenous labour futures in an automated mining industry, this same commitment to evidence-based data must be applied to understanding the impact on Indigenous peoples.

In the mining sector, drilling, blasting, and train and truck driving typically constitute over 70 percent of mining employment.[35] These routine jobs are the target for automation, and they are disproportionately where Indigenous peoples are employed in manual and semi-skilled roles.[36] More specifically, recent Australian census data indicates that machinery operators and drivers continue to account for the bulk of Indigenous employment in mining (55%), followed by technicians and trades workers (24%), labourers (6%) and professionals (5%).[37] In Australia, some of these entry-level positions are already disappearing. An early estimation suggested that fully autonomous equipment would reduce the workforce of a typical open-cut, iron-ore mine by 30 to 40 percent.[38]

In Canada, similarly to Australia, Indigenous peoples are over-represented in entry-level jobs and under-represented in engineering and geological roles.[39] Low rates of formal education in remote areas pose fundamental barriers to employment. In the context of mine automation, this issue will only become more pressing. Venn and Biddle confirm that "the skills and qualifications of the non-employed are poorly matched with recent growth of employment opportunities".[40]

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[34] Institute for Sustainable Development (IISD) and Colombia Centre on Sustainable Development. 2016. *Mining A Mirage? Reassessing the shared-value paradigm in light of the technological advances in the mining sector.* Available at https://www.iisd.org/library/mining-mirage-reassessing-shared-value-paradigm-light-technological-advances-mining-sector.

[35] IISD and Colombia Centre on Sustainable Development. 2016. *Mining a Mirage? Reassessing the shared-value paradigm in light of the technological advances of the mining sector.* Available at https://www.iisd.org/library/mining-mirage-reassessing-shared-value-paradigm-light-technological-advances-mining-sector.

[36] Brereton et al. 2013. "Autonomous and remote Operation Mining: Capturing the Societal Benefits for Australia". Brief Series. CSRM
See also CSRM. 2007. "Survey of Aboriginal Former Employees and Trainees of Argyle Diamond Mine". Centre for Social Responsibility in Mining. University of Qld. Available at https://www.csrm.uq.edu.au/docs/Argyle%20former%20employees%20final%20report.pdf.

[37] Unpublished data from the 2011-2016 census, provided by Danielle Venn (ANU, Canberra).

[38] McNab et al. 2013. *Exploring the social dimensions of autonomous and remote operation mining: Applying Social Licence in Design*.

[39] Canadian Minerals Sector Employment Information Bulletin 2016. http://www.nrcan.gc.ca/mining-materials/publications/16739.

[40] Venn, D. and Biddle, N. 2018. "Employment Outcomes: 2016 census papers". Centre for Aboriginal Economic Policy Research, ANU, Canberra. Available at http://caepr.cass.anu.edu.au/sites/default/files/docs/2018/6/CAEPR_Census_Paper_5_2018_0.pdf.

The growth of Indigenous employment in the past two decades is partly the result of industry support for "work ready" programs for Indigenous employees. These programs often match the commitments negotiated in local-level agreements to support training that will lead to employment in the industry, while they also develop the local employee base for an operation. Such training is recognised as providing a crucial pathway to work that can be transferable beyond the life of mine.

As a case study, the Kworp Kooling Mining Traineeship Program for BHP Billiton Iron Ore (Australia) illustrates the breadth of content covered in a work ready training program for Indigenous staff. Technical training is complemented by learning modules to empower Indigenous trainees to be successful in their industry roles and achieve positive employment and social outcomes.[41] These modules include: realities of fly-in/fly-out (FIFO) employment; healthy lifestyles; financial literacy; goal setting; lateral violence and conflict resolution. The formal qualification achieved is a Certificate II in Surface Extraction. BHP indicates that the program's success is based on its practical nature.

This work-ready program case study offers insight into several issues. The first is that work-ready programs are usually aimed at skills development and broader capability building, with application beyond the mining industry. This is, in itself, a valuable social good. As a result, such training becomes an important sustainability outcome and fills a gap that mainstream forms of education appear not to have been catering to. Yet, it raises questions about whether such work-ready programs will be available if the roles for which people are currently being trained are automated, and no longer exist.

Secondly, the fact that Indigenous pre-employment programs are needed highlights educational disparities between Indigenous and non-Indigenous populations. Such educational disparities are apparent for the Indigenous population globally.[42] Developing educational systems for the workforce of the future will have specific implications for Indigenous peoples who rely on mining industry employment. Consideration should be given to the potential that technology could bring to remote communities by way of connectivity, technological infrastructure and associated economic opportunities. A focus on school-to-work transitions for Indigenous students is one area of potential research, as student use of digital technologies in schools has become standard. Mining companies, researchers, and governments must focus on remote regions, as this is where states struggle to deliver services.

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[41] Western Australian Government. 2016. Chamber of Minerals and Energy (CME), Report *Growing Aboriginal Participation* Case Study – BHP Billiton Iron Ore's Kworp Kooling Mining Traineeship Program (2016: 8-9).

[42] For instance, in Guatemala, more than 50 per cent of Indigenous youth aged 15-19 have not completed primary education, compared to around one-third of non-Indigenous youth. While a sizeable gap persists between the number of years of schooling attended by Indigenous and non-Indigenous children. The gap ranges from non-Indigenous children in Peru receiving 2.3 years more education than their Indigenous classmates, to a gap of nearly four years for Bolivia. In the UN *State of the Worlds Indigenous Peoples*. Available at http://www.un.org/esa/socdev/unpfii/documents/SOWIP/press%20package/sowip-press-package-en.pdf.

These pre-employment programs for Indigenous peoples have proven successful, not only in lifting the employment rate within the industry, but also in the development of transferable skills.[43] However, this now standard approach by many companies to ensuring the skilling up of Indigenous workers, notably those in remote areas, is challenged in this emerging high technology domain. What level of upskilling will be required for the remote Indigenous workforce to move beyond the current 'shovel ready' standard? What potential niches will remain *in situ* that can be further developed?

3.1.3 Diversity within the Indigenous workforce

There is considerable diversity amongst Indigenous populations. In Australia for example, there is a significant disparity in educational attainment between urban and remote areas.[44] This educational disparity, related to geographic location, is also mirrored by the Indigenous Canadian population.[45] Though new technology would appear to exclude many Indigenous workers, because it requires high levels of education and expertise, outcomes are likely to vary across the Indigenous mining workforce.

Because of the diversity and variation across the population, we cannot forecast what the transition will look like, without more granular data. In Australia, for instance, the census data on employment is aggregated. While we know that there are unprecedented numbers of Indigenous employees in the industry, no published data exists to show whether new Indigenous miners are locals leveraging native-title rights to access nearby jobs, or if they are FIFO Indigenous workers living elsewhere, employed as part of the burgeoning Indigenous middle class.[46] We can assume that the majority are locals due to the increasing prevalence of negotiated agreements and associated commitments to ensure local employment. However, in mining regions such as the Pilbara region of Western Australia, there is often a combination of local and non-local Indigenous employees and census data does not disaggregate the two.[47]

There is evidence to suggest that remote Indigenous mine workers are likely to be the least vulnerable within their own communities.[48] These

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[43] CSRM. 2007. "Survey of Aboriginal Former Employees and Trainees of Argyle Diamond Mine". Centre for Social Responsibility in Mining. University of Qld. Available at https://www.csrm.uq.edu.au/docs/Argyle%20former%20employees%20final%20report.pdf.
[44] Biddle, N. 2013. *CAEPR Indigenous Population Project: 2011 Census Papers. Paper 8. Part Two School Education*. Available at http://caepr.cass.anu.edu.au/sites/default/files/docs/2011CensusPaper08_Education_Part 2_Web_1.pdf
[45] Gordon, C and White, J. 2014. "Indigenous Educational Attainment in Canada". In *International Indigenous Policy Journal.* Vol 5, Issue 3. Article 6.
They state that "The most alarming difference is Nunavut (remote province) where 73% of the Indigenous population has less than a high school education and 15% has a post-secondary education.
[46] Langton, M. 2013. *The Boyer Lectures 2012. The Quiet Revolution: Indigenous People and the Resources Boom.* Harper Collins, Sydney.
[47] Taylor, J. 2009. "Data mining: Indigenous peoples, applied demography and the resource extraction industry". In [eds] Altman, JC and Martin, DF. *Power, Culture, Economy: Indigenous Australians and Mining. CAEPR Research Monograph 30,* Australian National University.
[48] Gray, M, Hunter, B and Biddle, N. 2014 The Economic and Social Benefits of Increasing Indigenous Employment. CAEPR Topical Issue No 1. Available at http://caepr.cass.anu.edu.au/sites/default/files/docs/Topical_Issue_01-2014_GrayHunterBiddle_EconomicSocialBenefitsIndigenousEmployment_0.pdf.

employees are likely to be supporting a larger family, members of whom may be at risk, or vulnerable. In remote contexts, given the extremely high levels of unemployment, those people who are employed are likely to have others relying on, or making claim to, their mining income. To understand dependency ratios, degrees of vulnerability, and the dynamics associated with mining and employment income, data needs to be granular and disaggregated. Rarely is census data adequate for these purposes.[49]

3.2 Local-level agreements

The growth in the political empowerment of Indigenous and minority peoples is reflected in the trend toward companies and communities negotiating contractual local-level agreements – such as land use agreements or community development agreements (CDA). These commitments can address compensation for loss, recognition of rights, management of impacts, and benefit sharing, such as through equity ownership. In the context of an increasingly automated mining industry, questions emerge about the ability of these agreements to adapt to rapidly changing circumstances. The ICMM's Position Statement on Indigenous Peoples, for example, requires member companies to apply the position statement to projects that are likely to have "significant impacts on Indigenous peoples". Parties may need to review the terms of these agreements in light of the industry's rapidly changing circumstances, and the potentially significant effects on some groups of local Indigenous peoples.

Negotiated agreements are increasingly common in virtually all mining regions of the world. Agreements have spread within countries that have in the past seen agreements negotiated only in limited contexts, and in countries that have not historically encouraged them. For instance, local agreements are now negotiated for virtually all projects that might affect Indigenous lands in Australia.[50] Fewer than 20 existed in 1990, while approximately 600 mining-related land use agreements, including Indigenous Land Use Agreements (negotiated under the *Native Title Act* 1993), exist in Australia currently.[51] A similar trend is evident in Canada, where there are now more than 400 mining related Indigenous agreements.[52] A decade ago, local-level agreements were virtually unknown in Africa, South America, Central Asia, South East Asia, and the former

> Negotiated local-level agreements are increasingly common in virtually all mining regions of the world.

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[49] See Taylor. J and Scambary, B. 2005. *Indigenous People and the Pilbara Mining Boom: A Baseline for Regional Participation.* ANU e-press. This study is an example of research that draws together a comprehensive range of quantitative data, including census data, and qualitative research to provide a granular level social impact baseline for the region.
[50] Agreements, treaties and Negotiated Settlements (ATNS) database. Available at https://www.atns.net.au/default.asp.
[51] See the ATNS website where approximately six hundred mine related agreements are listed. There are 2,107 Australian agreements listed covering a range of topics (including horticulture and land planning) and some overlap between categories. Available at https://www.atns.net.au/browse.asp.
[52] Mining.Com. 2018. "Major Mines Increasingly Tapping Canadian Indigenous Labour Force". Jan 31, 2018. Available at http://www.mining.com/web/major-mines-increasingly-tapping-canadian-indigenous-labour-force/.

Soviet Union. Agreements are now also regularly negotiated in these regions.[53]

As opportunities for direct engagement with industry on mutually agreed terms have expanded over the last three decades, so too have they become more market-oriented, with a shift from a benefaction or compensatory approach, to a participatory one. For instance, early mining agreements negotiated under the Australian Northern Territory Aboriginal Land Rights Act (1976), focused on royalty payments as land-use compensation. At that stage, consideration was not given to training and employment for agreement beneficiaries as rights holders. Indigenous aspirations have actively evolved such that today, these negotiated and binding agreements include training, employment commitments and procurement targets. For instance, all of Rio Tinto's iron ore agreements for their Pilbara region operations (in Western Australia) specify that the local Aboriginal workforce will reflect the Aboriginal population level in the Pilbara, which in 2015 was around 12 percent.[54]

Agreements increasingly contain provisions, including specific actions, to ensure that targets are met, such as via implementation strategies. These strategies can include not only traineeships and pre-vocational programs, but also local educational partnerships, recruitment priorities, dissemination of information about vacancies, selection strategies, counselling and family support programs and retention of workers.

Contractual arrangements for local procurement are also increasingly recognised in agreements. For instance, the Rio Tinto Diavik Diamond mine in Canada's Northwest Territories spent more than CAD 1 billion with First Nations businesses in the first years of construction, from 2000, while the Diavik socioeconomic monitoring agreement targets 70 percent of the mines expenditure to local Northern and First Nations businesses. These outcomes are achieved by procurement practices that prioritise Northern and First Nations businesses.[55]

While it is clear that existing local-level agreements play an important role in Indigenous employment, the implications of automation on the implementation of these agreements are yet to be understood. This is a significant knowledge gap. As local Indigenous training and employment and procurement targets are consistently a key feature, are Indigenous peoples in a position to engage with and take advantage of the move to automation? Are the Indigenous organisations that manage the

> Existing local-level agreements play an important role in Indigenous employment, the implications of automation on the implementation of these agreements are yet to be understood.

[53] O'Faircheallaigh, C. 2013. "Community development agreements in the mining industry: an emerging global phenomenon". In *Community Development*, 44:2, 222-238, and Anguelovski, I. (2011). "Understanding the dynamics of community engagement of corporations in communities: The iterative relationship between dialogue processes and local protest at the Tintaya copper mine in Peru". In *Society and Natural Resources*, 24, 384–399. And CSRM (Centre for Social Responsibility in Mining). (2011). ERM extractive industries source book, Good practice notes on community development agreements. Brisbane: CSRM. Available at https://www.csrm.uq.edu.au/Portals/0/docs/CSRM-CDA-report.pdf.

[54] Rio Tinto 2016. Why Agreements Matter: How To Guide. Available at https://www.riotinto.com/documents/Rio_Tinto_Why_Agreements_Matter.pdf.

[55] Rio Tinto. 2016. Why Agreements Matter: How To Guide. Available at https://www.riotinto.com/documents/Rio_Tinto_Why_Agreements_Matter.pdf.

agreements in a position to adapt to this change? Are the implementation strategies geared toward the possibilities of automation? Questions, such as how these agreement targets will be met, in the move to automation, will be key issue for all stakeholders.

Indigenous and minority groups with the most to lose from the potential polarising and exclusory effects of mining automation are those for whom the local-level agreements have been negotiated to include binding commitments to training, employment, and local procurement of goods and services. In an automated mining industry, on-site roles change, potentially reducing the numbers of jobs available locally and shifting the skills base and economic activity to urban centres. The loss of entry-level routine jobs – most suited to Indigenous peoples who are engaging in a market economy for the first time – creates the greatest risk.

New mines, such as Rio Tinto's Koodaideri mine (in Western Australia's Pilbara region), which the company claims will be the most technologically advanced in the world, will require 2000 workers during construction, and 600 workers during the "intelligent operation".[56] While it is likely that employment arrangements during construction would be largely unchanged, employment options during the years of operation are likely to be most impacted by automation. The company negotiated a "comprehensive land use agreement" with the Yinjibarndi native title holders that included this project in 2013.[57] The extent to which this agreement has engaged with the shift to automation could be an early indicator of industry preparedness to embrace the challenges the new technologies bring to local Indigenous workforces.

In these diverse global contexts, there has been "constant innovation in the detail about how local-level agreements are negotiated and structured to solve particular contextual challenges".[58] This adaptive approach to local contexts potentially holds promise and equally perhaps much expectation. Will agreements be able to manage potential benefit sharing changes as the industry shifts to automation? What will the alternative value proposition be when local training and employment opportunities are no longer available?

3.3 State regulatory requirements

There has been a global shift toward state regulation to manage for many of the impacts of mining. Though the focus may have initially been on managing the bio-physical impacts, regulation is increasingly encompassing the social and economic impacts of mining. According to Dupuy, since the mid-1980s, 32 countries have adopted community development requirements into their mining laws, while a further nine

State regulation is increasingly encompassing the social and economic impacts of mining.

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[56] "Rio Tinto approves funding for its first intelligent mine" Media Release. 2018. Available at http://www.riotinto.com/media/media-releases-237_25968.aspx.

[57] "Rio Tinto celebrates new comprehensive land use agreement with Traditional Owners in the Pilbara". Available at http://www.riotinto.com/media/media-releases-237_8787.aspx.

[58] Harvey, B. 2018. "Vignette: Local Level Agreement Making in the Extractive Industries-A Viewpoint on Context, Content, and Continuing Evolution". In Martin J. Clifford, Robert K. Perrons, Saleem H. Ali, Tim A. Grice [eds] 2018. *Extracting Innovations: Mining, Energy, and Technological Change in the Digital Age*.

countries are in the midst of doing so.[59] These laws target the equitable distribution of resource revenues and benefits.

Thus, where there are no requirements to negotiate local-level agreements with Indigenous or First Nations peoples (and where such groups do not exist or are not formally recognised), these mining sector legal reforms operate to some extent in their stead. For instance, in Guinea, West Africa, community development laws, introduced in 2011, compelled a commitment to local business for Rio Tinto in relation to their Simandou project. As the Company states, "in the absence of a formal community agreement, the local business development commitment is written into an agreement with the government". This development has included training for local small and medium enterprises, some of whom obtained contracts with Rio Tinto and Rio Tinto contractors.[60]

Likewise, Mongolia has recently established a mining law and policy framework that requires companies to develop agreements with local and regional administrative bodies to promote integration of benefits locally. Specific benefits include requiring developers to pursue local-level 'job creation' opportunities.[61] The title of this legal requirement is "The Model Agreement on Issues of Environmental Protection, Mine Exploitation, and Infrastructure Development in Relation to Mine Site Development and Jobs Creation (2016)".

Though Dupuy does not list Australia as one of the countries with laws stipulating community development, some states, such as Queensland, do have soft law requirements for local and Indigenous employment as part of their approval process. For instance, it is "recommended that mining projects implement Local and Indigenous Employment and Business Development plans with reference to the Queensland Resource and Energy Sector Code of Practice for Local Content (2013)". The state government also suggests that the proponent develop a reporting framework to include local spend, employment details and participation in development, training and skills programs.[62]

This expanding global suite of hard and soft laws, requiring the industry to ensure local-level employment and procurement for operations, does not take into account the rapid emergence of automation. High technology mining companies will be increasingly challenged in their ability to meet these requirements, and deliver on their commitments.

[59] Dupuy, 2014. Community Development Requirements in Mining Laws, 1993-2012. In Extractive Industries and Society. 1 (2), 200-215.
[60] Rio Tinto. 2016. Why Agreements Matter. See p85 for 5 examples of agreement commitments for procurement from host communities. Available at https://www.riotinto.com/documents/Rio_Tinto_Why_Agreements_Matter.pdf.
[61] Intergovernmental Forum on Mining Metals and Sustainable Development. 2017. *IGF Mining Policy Assessment: Mongolia*. Intergovernmental Forum on Mining Metals and Sustainable Development. International Institute for Sustainable Development (IISD).
[62] Queensland Resources Council (QRC). "Local Content". Note that they state; "The *Queensland Resources and Energy Sector Code of Practice for Local Content 2013* (the Code) is an industry-led self-regulated initiative. Compliance with the Code is voluntary but strongly encouraged, particularly among the membership of the QRC". Available at https://www.qrc.org.au/policies/local-content/.

3.4 Mining company policies and commitments

Another layer of commitment to Indigenous training, employment and procurement can be found in company policies and accounted for in the annual cycle of sustainability reporting. Many mining company policies now reflect the extensive body of global corporate social performance standards and the industry has become active in voluntary sustainability reporting.[63] Such reporting, including the disclosure of non-financial information, has emerged as a crucial strategic consideration for mining corporations to generate social acceptability for operations over the last two decades. Providing data on employment totals for Indigenous and local staff also now form a standard component of the annual reporting in many corporate sustainability reports.

Mining companies that are members of the ICMM and other voluntary industry bodies, such as the MCA and the MAC, draw from the ICMM's Position Statement on Indigenous Peoples and Mining. This position statement is clear in its support for the principle of ensuring benefit sharing in local operations, as it recognises the potential vulnerability of Indigenous peoples. In this statement, the ICMM draws on the International Labour Organization (ILO) *Convention No. 169 on Indigenous and Tribal Peoples* (1989), and the *UN Declaration on the Rights of Indigenous Peoples* (UNDRIP).[64]

For instance, BHP's "Indigenous Peoples Policy Statement" states that, "Indigenous Peoples are critical partners and stakeholders in many of BHP's operations both within Australia and around the world."[65] Their approach to the "economic empowerment" of Indigenous Peoples will be to contribute to investment which provides opportunities for employment, training, procurement and Indigenous enterprise support." BHP lists a range of comprehensive "core commitments" including: develop and implement Indigenous Economic Empowerment Plans, which will include milestones and targets for one or more of the following: 1) pre-employment training, employment, career development and retention of Indigenous employees; 2) business procurement from Indigenous enterprises; and 3) Indigenous peoples vocational training and livelihood support through voluntary Social Investment Plans.[66]

According to Rio Tinto's recruitment priorities, "the principle of the best person for the job can include criteria recognising the value of employees with an attachment to the land. A hierarchy of preferred applicants applies at some sites." They provide an example of their Canadian Haisla Nation-

It is not only major companies committed to the international norms and standards that have developed Indigenous employment policies, but also mid-tier and junior companies, and major contractors.

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[63] We acknowledge that Sustainability reports can have a level of performativity to them and that there can be a disjuncture between the company's self-assessment and the assessment by civil-society and other stakeholders of the company's 'triple bottom line'.

[64] ICMM Position Statement on Indigenous Peoples and Mining. 2013. Available at https://www.commdev.org/wp-content/uploads/2015/06/ICMM-Indigenous-Peoples-and-Mining-Position-Statement.pdf.

[65] BHP Indigenous Peoples Policy Statement. Available at https://www.bhp.com/our-approach/operating-with-integrity/indigenous-peoples/bhp-indigenous-peoples-policy-statement.

[66] BHP Billiton's Global Indigenous Peoples Strategy. Available at https://www.bhp.com/-/media/documents/ourapproach/operatingwithintegrity/indigenouspeoples/170622_bhpbillitonindigenouspeoplesstrategy.pdf?la=en.

Rio Tinto Alcan Legacy Agreement that creates a local employment preference for First Nation applicants for both Rio Tinto's aluminium business and its contractors.[67]

It is not only major companies committed to the international norms and standards who have developed Indigenous employment policies, but also mid-tier and junior companies, and major contractors. While this is partly due to the commitments negotiated as part of local-level agreements, the growing acceptance of the principles of inclusion, diversity and Indigenous recognition have also compelled this change. For instance, Panoramic Resources, an Australian mid-tier company has an "Indigenous Employment Policy: Building Brighter Futures in Remote Communities" which, they indicate, ensures the representation of Indigenous people within its workforce. They also acknowledge their "responsibility to enhance the economic and social outcomes within the communities [they] operate in and [are] committed to supporting the employment of Indigenous Australians in all of [their] practices and workplaces".[68]

In settler colonies, such as Canada and Australia, there is increasingly an expectation that the extractive industries, like other private sector industries, have a role to play in reconciliation with Indigenous peoples.[69] An expression of this recognition is in the increasing adoption by companies of Reconciliation Action Plans (RAPs), which aim to promote inclusivity in the recognition of Indigenous prior rights and interests. For its Australian operations, Anglo American's RAP "outlines [their] commitment … to employment, supplier engagement, education pathways and scholarship opportunities for Aboriginal and Torres Strait Islander Peoples".[70]

The Canadian National Aboriginal Economic Development Board recognised this link between employment and reconciliation with its First Nations peoples in the recent report: *Reconciliation Canada: Growing Canada's Economy by 27.7 million*.[71] The Report focuses on the fiscal benefits to the national economy if there was employment parity between First Nations peoples and the mainstream. Canadian based company Teck Resources recognises the alignment between enabling equal opportunity for employment and reconciliation for Indigenous peoples. In 2015, Teck formalised its Indigenous Peoples Policy and has been working with Reconciliation Canada on a company RAP.[72] In their 2017 Sustainability Report Teck states that, "together, we can help move into a new era of

> The shift toward increasing the quota of Indigenous peoples in the mining workforce has been part of a broader push that recognises the benefits of establishing a diverse workforce.

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[67] Rio Tinto 2016. Why Agreements Matter: How To Guide. Available at https://www.riotinto.com/documents/Rio_Tinto_Why_Agreements_Matter.pdf.
[68] Available at http://panoramicresources.com/wp-content/uploads/2015/08/Indigenous-Employment-Policy.pdf.
[69] Mining.Com. 2018. "Major Mines Increasingly Tapping Canadian Indigenous Labour Force". Jan 31, 2018. Available at http://www.mining.com/web/major-mines-increasingly-tapping-canadian-indigenous-labour-force/.
[70] Available at http://australia.angloamerican.com/~/media/Files/A/Anglo-American-Australia-V3/document/reconciliation-action-plan-reflect-2014-2015.pdf.
[71] Available at http://naedb-cndea.com/reports/naedb_report_reconciliation_27_7_billion.pdf.
[72] Mining.Com. 2018. "Major Mines Increasingly Tapping Canadian Indigenous Labour Force". Jan 31, 2018. Available at http://www.mining.com/web/major-mines-increasingly-tapping-canadian-indigenous-labour-force/.

reconciliation that bridges social and economic gaps and builds relationships with Indigenous Peoples. Doing so will also help to advance UN SDG 8 on decent work and economic growth".[73]

Increasing the quota of Indigenous peoples in the mining workforce has been part of a broader push that recognises the benefits of establishing a diverse workforce. Indigenous peoples and minority groups are cited as a key demographic of such a workforce. Diversity is understood as a common recruitment challenge in the mining industry and, according to the Canadian site Mining.com, the industry is placing diversity at the heart of their human resources effort. 'Diversity Management' employment systems have become a methodology increasingly adopted by employers to effectively manage and monitor a more balanced workforce.[74]

This raft of social performance policies, standards and social contracts is heavily reliant on the opportunities for mainstream job creation that the industry offers. Automation operates as a potential disruptor. Automation may mean that local workforces and local or regional procurement are no longer able to contribute to social performance. If so, what other creative, market-driven ways can be pursued to achieve social performance outcomes, and reduce vulnerability of Indigenous communities? Currently, we see no adjustment back into the corporate policy arena.

4   An agenda for future research

The mining industry is in some ways both an exemplar of and a litmus test for the broader economic transition that is occurring within Australia, and globally. To date, the mining industry's narrative has been focused on the upsides of new technologies to improve operational efficiencies and worker safety in a tighter market. These same companies are largely silent on the downside risks that these new technologies may pose for local employees and communities. We suggest that this is notably the case for Indigenous employees and communities. Early indications are that high technology mining has the potential to act as a significant disruptor to the gains that have been made in Indigenous mining employment.

In this preliminary scoping of the potential impact of mine automation on Indigenous employment futures, we identify five key topic areas:

- risk and impact
- work and welfare
- work and education
- land and the Indigenous estate
- human rights and development.

4.1   Risk and social impact

Transitioning to new forms of extraction may not be negative for all employees. Gradations of impact are likely to be related to vulnerability. An

> Early indications are that high technology mining has the potential to act as a significant disruptor to the gains that have been made in Indigenous mining employment.

[73] Teck Sustainability Report 2017. Available at https://www.teck.com/media/Teck-2017-Sustainability-Report.pdf.

[74] Mining.com Canada. 2018 May 29. Available at http://www.mining.com/sc/current-employment-trends-mining-industry/.

important research question is therefore: what is the scale and the nature of potential impact? Questions of scale can be further considered in terms of the extent of the disruption, and what are the risks and to whom do they apply? Risk must be considered across the stakeholder spectrum; employees and communities; industry; government and civil society.

Currently, we have little understanding of the scale of the issue for different stakeholder groups and, most crucially, for Indigenous landowners who have begun to rely on this employment. There is a wide recognition that technological innovation will continue to change the nature of work in mining and therefore skills requirements, yet this recognition has yet to transfer to the Indigenous workforce.

It is difficult to engage this question of scale without a deeper body of knowledge about the Indigenous workforce. This includes data about workforce diversity, mobility, dependencies and vulnerabilities. Without robust empirical data, we are not able to track the effects of automation on the Indigenous workforce. We have no indication from industry to suggest that this risk is being tracked. In the downturn, there was a withdrawal from industry research in this area, yet we are not seeing investment in the face of a market upturn.

Big picture risk issues include local-level acceptability and how free prior and informed consent (FPIC) will be re-negotiated due to operational changes. We know that relationships at the community level increasingly influence the viability of the operations. What risks and opportunities will emerge for local communities? How will new technologies impact community trust? Will technological changes impact community perspectives about the impacts and benefits of mining?

4.2 Work and welfare

For Indigenous peoples in settler colony states, such as Canada and Australia, direct and indirect employment has become an important means to transition away from the welfare economy, and towards greater autonomy. This significant shift from "payout" to "participation" could be at risk from mine automation.

What will happen if certain jobs fall out of the mining system? Will there be a reversion to passive receipt of compensation and a simple beneficiary model? Are these same companies who developed the current work-ready programs also prepared to develop the innovative programs that may increasingly become necessary to ensure that employment growth is maintained?

The gains made in Indigenous employment are due to industry innovation in 'work-ready' pre-employment programs as a key mechanism for increasing Indigenous participation in the mining workforce. Yet, we know little about the deeper "social good" of these programs, and how they may constitute local forms of development.

4.3 Work and education

The challenges to upskilling mainstream populations to meet the needs of the high technology industries of the future, including the mining industry,

are now apparent. There is now a concerted focus by industry bodies, such as the MCA and MAC, to address future minerals workforce and skills requirement in growth areas such as automation, robotics, artificial intelligence and data analytics.[75] What sort of educational programs will be required to ensure both ongoing Indigenous employment and the next generation of Indigenous employees in this sector?

If the current work-ready programs are no longer sufficient, then the state-based education system has a significant gap to fill. Education and employment data for Indigenous peoples, at both a global level, and more specifically in Canada and Australia, indicate that this is a major area of disparity and vulnerability.

The complex intersection between capability development, the social practices of literacy, and the emergence of new media in remote communities is a growing field of research.[76] Indigenous peoples are engaging with digital technologies in innovative ways.[77] The potential intersection between existing digital skills, including those used socially, and the new data sciences being led by industry, are yet to be explored. New types of Indigenous engagements in land management and mined land rehabilitation, for example, hold significant potential.

An interrogation of the limitations of the mainstream education system provides an impetus to focus more closely on the skill-sets that Indigenous peoples – particularly those peoples in remote areas – most value. In these contexts, value may reside in local knowledge and place-based assets, rather than transferability and mobility. Consideration of alternative livelihood and benefit sharing models that develop and support local economies may be more sustainable beyond life of mine. These options, including those within agreements, will require close and careful consideration.

4.4 Land and the Indigenous estate

Points of interface between the Indigenous estate and mining are set to increase. Yet, we have limited visibility of resource extraction and exploration on or adjacent to Indigenous lands globally. A mapping project to determine intersecting interests would be foundational for understanding the future scale of mining industry engagement with

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[75] See MCA "Workforce, Education and Skills". Available at https://www.minerals.org.au/workforce-education-and-skills.

[76] Kral, I and Schwab, R.J. 2003. "The Realities of Adult Literacy Acquisition and Practice: Implications for Capacity Development in Remote Communities." *CAEPR Discussion paper 257*. Australian National University, Canberra. Available at https://openresearch-repository.anu.edu.au/bitstream/1885/39964/3/2003_DP257.pdf.
 Kral, I and Schwab, R.J. 2012. *Learning Spaces: Youth Literacy and new Media in remote Indigenous Australia*. ANU e press. Canberra.

[77] "Aboriginal Rangers Get Hands on with the Latest Technologies". 2017. NITV. Available at https://www.sbs.com.au/nitv/culture/article/2017/10/12/aboriginal-rangers-get-hands-latest-technologies.
And see for instance, the "I-Tracker" (Indigenous Tracker) technology used by the North Australian Land and Sea Unit (NAILSMA) that uses the cybertracker software. Available at https://www.nailsma.org.au/hub/programs/i-tracker.html.

Indigenous peoples.[78] This would be a significant and complex methodological project requiring international collaboration and expertise combining global information systems (GIS) and qualitative research methods.

If these points of interface between the industry, Indigenous peoples, and their lands increase, we assume that negotiated local-level agreements will also increase. Adaptation to the impact of new technology and mine automation will be required for new and existing agreements.

The implications of mine automation for existing agreements is a significant knowledge gap. As local Indigenous training and employment targets are consistently a key feature of these agreements, we must ask whether Indigenous organisations and representative bodies are in a position to engage with, and potentially take advantage of, opportunities associated with mine automation. Are the new agreements that are emerging being geared toward an automated mining industry? Are local people aware of the changes that may result from the introduction of new technologies? How employment targets will be met in the move to automation will be a key question for all stakeholders.

What are the alternative value propositions for indigenous peoples when employment opportunities are no longer available as part of the package of benefits that mining companies seek to negotiate in return for access to land? Options for consideration include a greater focus on equity shares, and partnerships in mine ownership.

4.5 Rights and development

What might a rights-based approach to the introduction of new technologies look like for the mining industry? The UN Guiding Principles on Business and Human Rights (UNGPs) state that companies should identify, prevent, mitigate, and account for how they address the adverse human rights impacts of their activities, operations, products, and services. This is positioned as a "do no harm" ethos.[79]

Deploying a rights-based approach to new technology, alongside the more conventional identification of risks and adverse impacts, takes into account the UNGP framework. Such human rights commitments require that companies exercise "due diligence". Will companies who have committed to the UNGP's be duly diligent on this issue?

Changes in technology can exacerbate inequality, while low-paid workers and jobs occupied by men are the most at risk globally, and also within the mining industry in the drive to automation.[80] How will the mining industry

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[78] Approximately two-thirds (69 percent) of people living in extreme poverty live in resource-driven countries (see also IISD 2016: 2). The issue of how common local-level agreements are in these countries is significant.

[79] Dunstan, A.H and Hodge, M. 2018, "Artificial Intelligence: A Rights-Based Blueprint for Business," BSR, San Francisco.

[80] The Guardian 2017. 'Exciting times'? Changes in technology can boost inequality, authors say'. Available at https://www.theguardian.com/technology/2017/apr/15/exciting-times-changes-in-technology-can-boost-inequality-authors-say.

contribute to fair work and equitable access to jobs if this Fourth Industrial Revolution is as significant as it is forecast to be?

Technological transformations will increasingly create a challenging environment for mining companies in their ability to operationalise their commitment to the UN's UNGPs and SDGs. How will their aspirational commitments to human development be met in light of the digital disruption?

5 Concluding remarks

Our hypothesis is that the recent gains made in Indigenous employment in the mining sector will be lost, if a targeted and systematic approach is not developed to understand and address this issue in the face of digital transformation. We urge the industry to support research that considers these issues in an open, constructive and inclusive manner with the engagement and participation of Indigenous peoples.

How will the industry's commitments to human development be met in light of the digital disruption?

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