The global mining industry, like so many other economic sectors, is in the midst of a technological revolution. What has long been considered a mature industry is going through a wave of technology-driven disruption. So transformational are the changes that there is not even useful language to capture the scope of what is taking place.

For example, “robot mines” is only suggestive of perhaps artificial intelligence and heavy equipment, but not the potential for big-data activities to fine-tune operations. Cyber mines on the other hand suggest “data mining”, but not traditional blasting rock. Thus, economist Brian Arthur’s term the “second economy” is perhaps the most evocative. As many of the elements of this ‘second economy’ are not yet present in Canada, this policy brief brings together the evidence on the leading edge of change from Australia to highlight what we might see over time in Canada.

As is always the case with the application of new technology, in some parts of the world there is a technological revolution underway. In other regions, companies are waiting to see if the technologies are robust in difficult environments and whether the business strategies pay off.

But, before we can start to interpret the change, we need a mind shift. To do that requires we divert our attention from minerals and commodities to the mining technologies. Traditionally, statistics have not been developed to make such an analysis easy. Back-of-the-envelope calculations could be possible, but perhaps that is a project for the future. The point is, mining technologies differ whether the extraction method is drilling, underground activities or open-pit activities. For example:

• Drilling based operations (particularly oil and gas) are deploying data and visualisation tools;
• Open pit mines are using autonomous heavy machinery; and
• Underground miners have found the conditions more difficult to develop and apply advanced new technologies—although at the leading edge there is transformation here as well.

This Policy Brief focuses on developments in Australia, which is considered a global leader in technological innovation in mining. While Canada is also embracing robotic mining and other advanced technologies, it is not as advanced as Australia. As concluded by Canada’s Economy Strategy Table that addressed the resource sector, Canada has shown a “lack of agility in technology adoption.”
Our core interest in this paper is identified in the following table.

Table 1: Areas of Interest

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<th>PROCESSING TIME</th>
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The most “sci-fi” like technologies are appearing in the open-pit mines in Australia’s western iron ore mines and eastern coal fields. A leader in technological innovation is the Anglo-Australian mining giant Rio Tinto, which is a global leader in the application of cutting-edge mining automation. Rio’s automation efforts are broad ranging, under what it labels the ‘Mine of the Future’ project.

Trucks (automated haulage)

The first technology of significance is the haul truck, the workhorse of the mine, which can be anywhere up to 400 tonnes gross weight. The media have struggled to understand the difference between remote controlled, ‘robot’ and ‘autonomous’. The available evidence suggests the equipment is autonomous, although monitored from 1,200km away in Perth. That is, they are self-driving and can determine when to stop and manoeuvre independently of an overseer in Perth.

The time line of change has been remarkably swift. Rio Tinto first introduced 12 Komatsu haul trucks for trial in 2008. By 2014 it had 30 working in the iron ore mines of Australia’s north-west Pilbara region. By 2015 it was being reported, “The first two mines in the world to start moving all of their iron ore using fully remote-controlled trucks have just gone online in Western Australia’s Pilbara”.

More recent information suggests that Rio Tinto has 76 autonomous haul trucks, BHP has probably 50 at the end of 2017 and Fortescue Metals Group is aiming for 168 driverless trucks. The evidence is that similar equipment is in Australia’s east coast open-pit coal mines being operated by BHP, but numbers for the equipment is less readily available.

Suncor in Canada (2018) has ordered 150 similar machines, appearing to jeopardise 400 jobs.

Rio’s “mine of the future” continues to evolve with the development and deployment of an extensive range of autonomous equipment.

Drilling Rigs

Rio Tinto uses drilling equipment to lay down explosives for open-pit operations. In this case it appears the rigs are not totally autonomous, but operated in sets of four from the Perth operations centre. By 2018 the drill sets had bored 5,000 km of blast holes for explosives.

Trains

In 2014, it was reported, ‘If all goes to plan, early next year a 32,000 tonne freight train laden with iron ore will roll out from a Rio Tinto mine site in the Pilbara region, bound for the port of Dampier 300km away on the West Australian coast. ...The big difference in 2015 is that instead of an onboard driver, the train will be remotely controlled by an operator sitting in a Perth control room 1500km to the south. After months of trials with driverless trains, Rio Tinto plans to begin scheduled operations next year as part of its “Mine of the Future” automation program’.

There were delays, but the ambitious $300 million research program has begun to pay dividends. In July 2018 it was reported that Rio’s “autonomous train, consisting of three locomotives and carrying around 28,000 tonnes of iron ore, travelled more than 280 kilometres from Rio Tinto’s mining operations in Tom Price to the port of Cape Lambert. It was monitored but not controlled remotely. The national regulatory body—”The Office of the National Rail Safety Regulator” provided final approval.

Speaking to a number of people in Canada there was scepticism about the applicability of the technology in Canada because of the difficulties of port access and problems of cold weather. However, the productivity improvements gained from this technology will put considerable pressure to the global mining industry wherever it is applied. As a result of its innovation Rio’s cost curve is the lowest of the major iron ore miners. In the podcast “Elements” on the BBC, a spokesperson for Rio Tinto estimated the company’s cost per tonne at $17. At about the same time the commodity price was USD$52. Verifying such boasts is hard, and comparing it against other actors which view such data as commercially sensitive virtually impossible.
Data Mining

Before explaining the trajectory of Rio Tinto’s data centres, it is important to give some context. Australia is an important global centre for mining software.

Exploration and mining software (EMS) has been a hugely innovative and an important segment of Australia’s $90 billion mining equipment, technology and services (METS) industry. (Austrade 2013) The segment of technology companies includes at least 50 dedicated firms based on two sub-segments: (1) information technology, and (2) specialised equipment (control, scanning, simulation and mineral processing technology). In 2012, these firms had total IT related sales of more than $1 billion, of which almost 50 per cent were exports, and employed an estimated 6,000 people. (Don Scott-Kemmis 2013 13) The sector is concentrated in Western Australia and Queensland (45 per cent and 30 per cent of firms, respectively)14.

With this background, it is understandable that Rio Tinto has established its data centres in Perth (Western Australia) and Brisbane (Queensland). The Perth Centre is an operations hub that oversees all Rio’s autonomous operations in Western Australia. Operators in Perth can take control of individual vehicles if necessary. But otherwise a more apt description is that the centre functions more like an air traffic control centre than a hands on operational facility.

The Brisbane centre oversees all Rio’s operations globally. Rio Tinto claims that five per cent of all energy usage on the planet is used in crushing rock. The Brisbane big data centre in real time monitors all rock-crushing activities in search of new efficiencies. As rocks of different grades pass through the processing facilities, the equipment can be fine tuned to deal with different types of rocks, whether harder or softer.

Productivity

The question this technology raises is does it matter? Costly, yes. Definitely “cool” in a technological sense. But does it improve productivity?

Across economics, productivity is considered crucial to sectoral success. If we examine the Australian data we can see some interesting productivity trends. Typically, people like to focus on labour productivity. We can compare Australian mining and agricultural productivity for some relativity, but international comparisons get more difficult. Agricultural productivity in Australia has been steadily growing since 1990.

Mining productivity had been declining in Australia, from approximately 2000 through to 2011-12. From there it stabilised, and since has been improving. While it is not possible to attribute this purely to the introduction of new technology, the timing of technological innovation and rising productivity is aligned.
People who are passionate about public policy know that the Province of Saskatchewan has pioneered some of Canada's major policy innovations. The two distinguished public servants after whom the school is named, Albert W. Johnson and Thomas K. Shoyama, used their practical and theoretical knowledge to challenge existing policies and practices, as well as to explore new policies and organizational forms. Earning the label, "the Greatest Generation," they and their colleagues became part of a group of modernizers who saw government as a positive catalyst of change in post-war Canada. They created a legacy of achievement in public administration and professionalism in public service that remains a continuing inspiration for public servants in Saskatchewan and across the country. The Johnson Shoyama Graduate School of Public Policy is proud to carry on the tradition by educating students interested in and devoted to advancing public value.

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