ST06 - Research and Development Perspectives in the Mining Industry

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Abstract

Companies across different sectors are investing considerable amounts of resources in research and development and they consider innovation as critical to guarantee their survival. Mining companies had been moving in the opposite direction in the last decades. Although reasons may differ among the companies, the common effect was a reduction of internal R&D teams with consequences to how mining companies deal with innovation. Recent changes intrinsic to the sector are challenging the *status quo* and the mining companies need to review their research and development strategies to stay competitive. This paper discusses the recent history and reasons leading to the reduction in R&D investment and the challenges faced by the mining sector requiring consideration in the current market scenario.

Keywords: Mining, Research and Development, Innovation, Strategy.

1. Short-Term History of R&D in the Mining Industry

Companies across a range of industries spent US$ 2.3 trillion in 2019, or 2 % of global GDP, in R&D [1]. The pharmaceutical industry leads the way spending 52 % of the EBITDA in R&D which equates to US$ 178 billion as shown in Figure 1 and Figure 2.

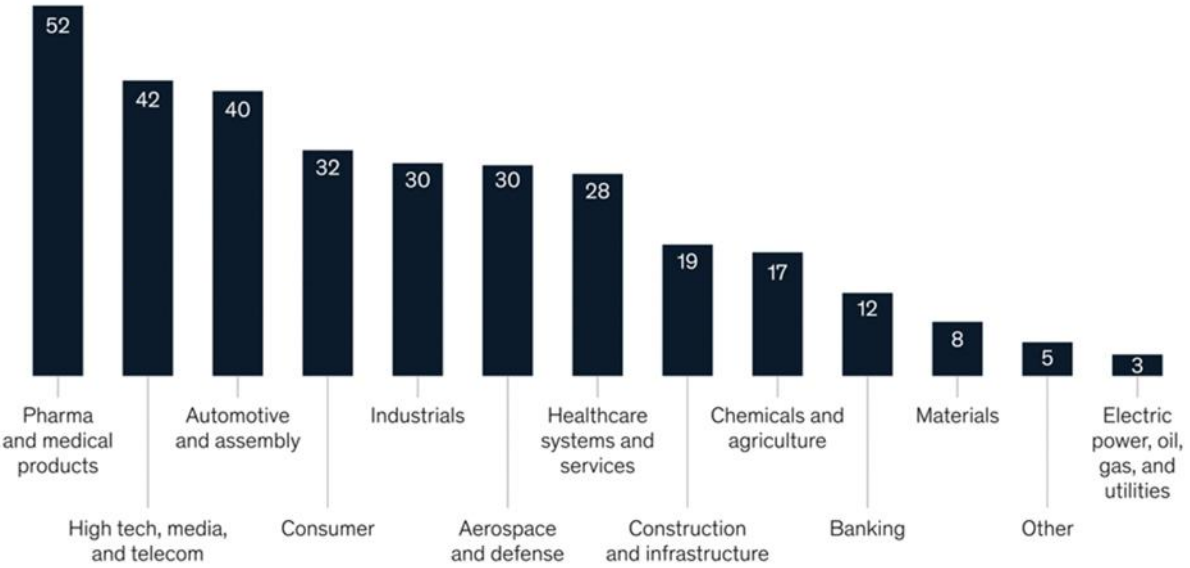

Figure 1. Global private-sector R&D spending as a share of EBITDA, in % [1].

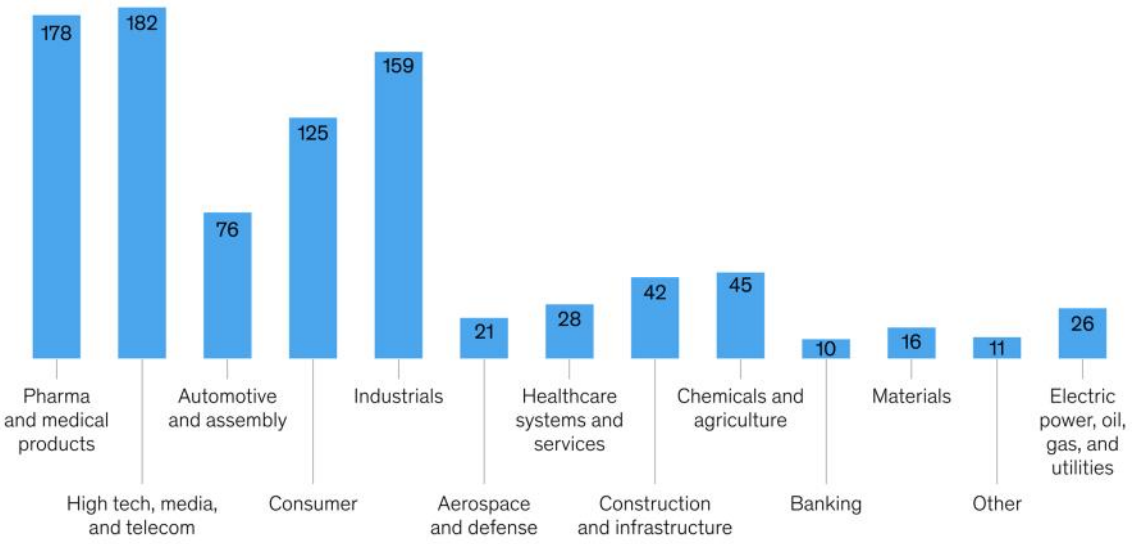

Figure 2. Total global private-sector R&D investment, in US$ billion [1].

Oil and gas, in comparison, spent only 3 % of EBITDA or US$ 28 billion in the same period. Mining industry is not stratified in the study, but it is traditionally lower than oil and gas.

The mining industry has a very low R&D intensity, around 0.5 % measured as R&D expenditure/Gross revenue, compared to other industries like IBM (6.1 %), Boeing (10.7 %) and AstraZeneca (13.4 %) [2] as shown in Figure 3.

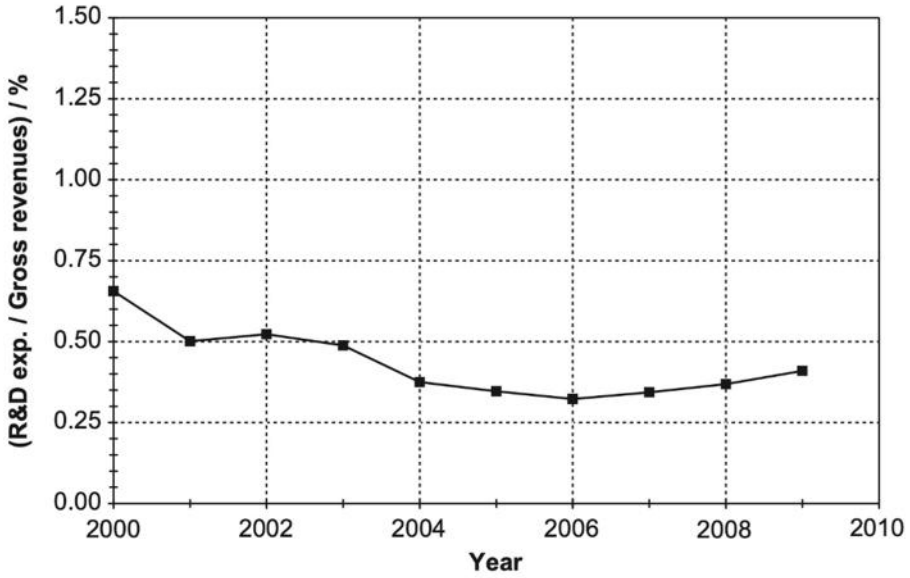

Figure 3. R&D spending trend in the mining industry, data from Alcoa, Anglo American, ArcelorMittal/Arcelor, BHP Billiton, Boliden, Cameco, Codelco, Eramet, Iluka, Rio Tinto, Sumitomo Metal Mining and Teck [2].

The graph shows that R&D spending in the mining industry steadily decreased up to 2006. The increase after 2006 is attributed to the reduction in revenue after the Global Financial Crisis (GFC) instead to an actual increase in R&D spending [2].

Mining companies' profit was high in the decade 2000-2010, before the GFC. It led to consolidation via mergers and acquisitions which then led to a reduction in the R&D departments and consequently R&D spending.

Global mining companies reduced their R&D departments when their focus turned into projects closely aligned with their core business [3]. BHP and Rio Tinto closing their in-house R&D laboratories and Alcoa reducing staff in its Pittsburgh R&D facility [4] are examples of the reduction of internal R&D in mining companies.

Although internal R&D services provides good service to operations, developing breakthrough innovation is a challenge to in-house research alone [5]. As stated by a mining firm executive [6]:

"*Our budgets seem to be used to solve short-term operational problems rather than to pursue long-term innovative solutions*".

More recent data [6] indicates the trend of low R&D investment in the mining industry continues after the GFC as shown in Figure 4.

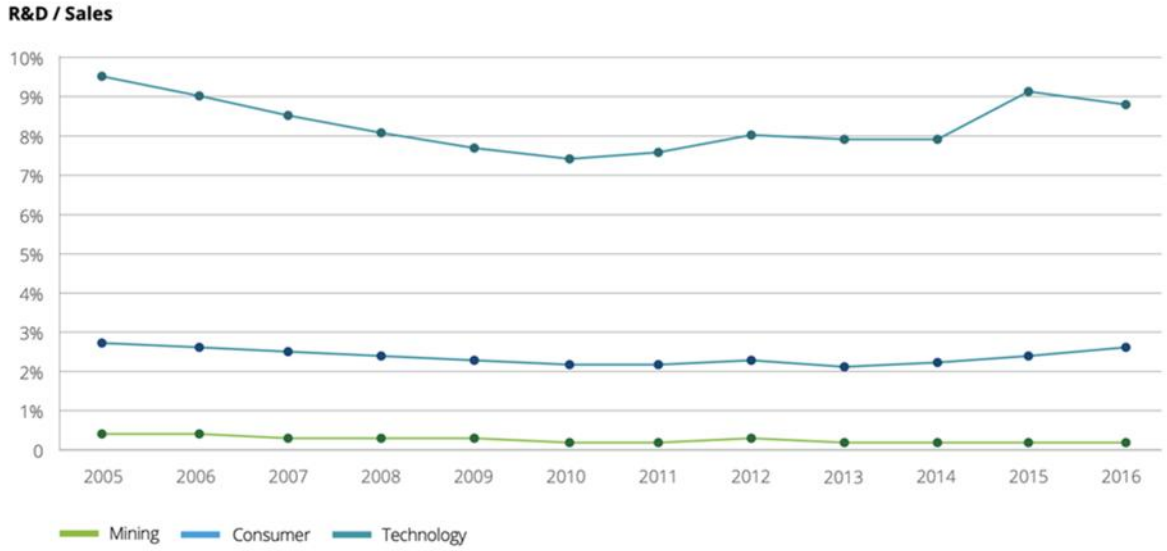

Figure 4. R&D spending trend in the mining industry after the GFC [6].

In summary, the R&D spending has been steadily dropping in the last two decades. Some factors that can be contributing to this decline are mentioned below.

1.1 Low Profitability

The mining industry has a lower return compared to other industries [7] as shown in Figure 5.

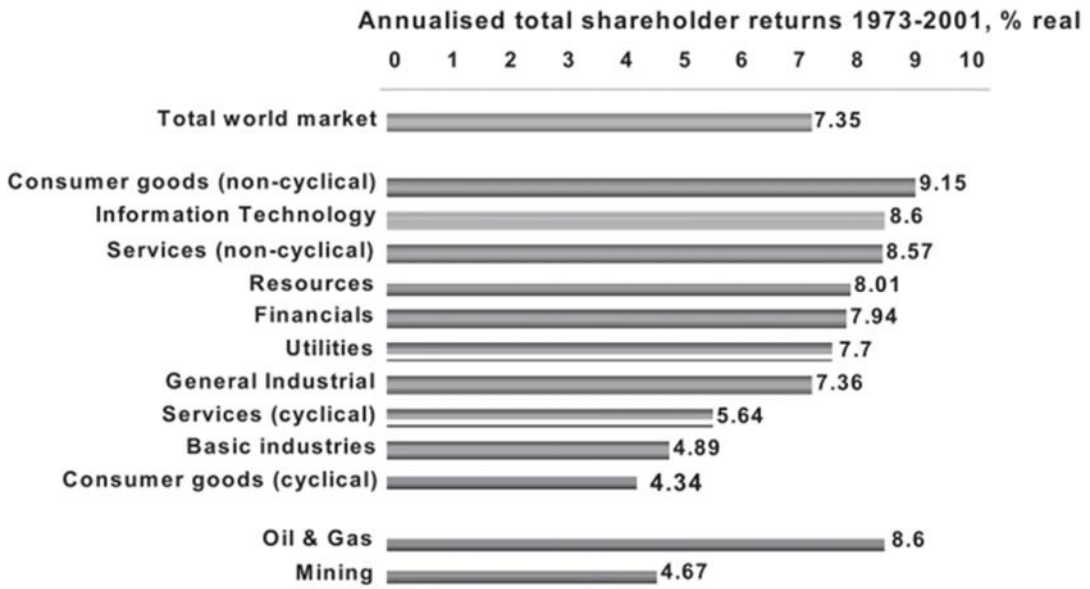

Figure 5. Return to shareholders for a selection of industries [7].

Most mining products are commodities, and the companies cannot adjust the price, becoming heavily impacted by factors outside their control and not linked to the financial fundamentals of the production process.

The CAPEX structure for most mining projects is also a contributor for the low profitability in mining when compared to other industries. Large CAPEX required and the long time until the projects provide return prevent start-ups entering the market which contributes to reduce innovation in the sector.

1.2 Commodities Market

As mentioned before, most mining products are commodities which prevent the companies to compensate for the losses during low turn cycles during the high turn cycles.

Also, the lack of product differentiation contributes to the problem preventing companies to charge premiums for their products. Most premiums are linked to product quality, and they are usually small.

There is a recent trend where companies try to differentiate their products with low carbon badges. These products can attract a premium, but they have basically the same quality as the traditional product.

1.3 Low Cooperation Among Companies

Traditionally, mining companies are very protective of their IP (Intellectual Property). IP is protected via patents and trade secrets leading to a very small number of cooperative projects.

Recent effort has been made to improve cooperation among industry peers. One example is the Bauxite Residue project coordinated by the International Aluminium Institute (IAI) where several companies cooperate to develop solutions for a common problem.

The low mobility of professionals in the mining industry also contributes to the problem. Usually, mine operations are in remote locations which are not attractive to employees. This proves to be worse when trying to recruit high specialized people like the ones required for a R&D department.

In summary, it is a fair assumption to say that mining companies are not listed among the most innovative. They are large and capital-intensive companies struggling to manage costs to keep a minimum margin and suffering from low product differentiation.

Pavitt [8] says that most innovations in the mining industry are related to cost reduction targeting to improve the margins. This causes most of the innovation to come from their own internal production or engineering departments or via products and services from specialized suppliers.

The list of factors affecting the decline of R&D in the mining industry can grow quickly but to keep the brevity of this article, we are going to stop on these three major factors.

Recent data confirm that across the board, mining industry has been focusing R&D effort to improve their core business with a strong emphasis on technological solutions to optimize old techniques “as needed” [9] as shown in Figure 6.

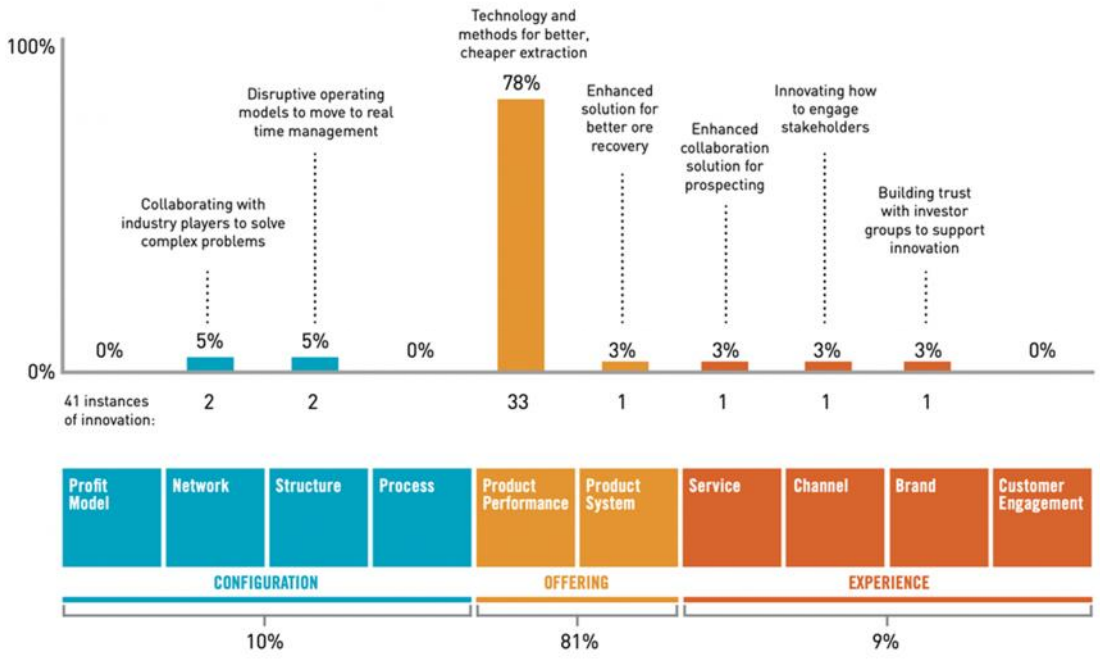

Figure 6. Mining innovation projects in different areas [9].

2. Factors Challenging the Current R&D Scenario in the Mining Industry

The question we must ask now is how sustainable is that scenario when looking for the challenges faced by the mining industry in the future?

There are several factors challenging the mining companies’ current R&D strategy and a few key areas requiring serious consideration are discussed in this section.

2.1 Raw Material Quality Deterioration

There is a natural tendency observed over the years for the reduction of the ore quality across several commodities [10] as shown in Figure 7.

	1953	1965	1975	1985	1995	2005
World Pb Production (kt)	1,870	2,784	3,570	3,248	2,750	3,298
World Zn Production (kt)	2,360	4,352	6,176	6,651	6,982	10,114
World Cu Production (kt)	2,600	5,070	7,185	8,365	10,180	15,076
Australian Pb Reserves / World Production	3.27	1.57	3.89	4.45	6.62	7.22
Australian Zn Reserves / World Production	2.24	1.00	3.13	3.19	5.56	4.13
Australian Cu Reserves / World Production	0.30	0.41	0.84	1.92	2.36	2.75
Australian Pb Production indexed (1953 = 100%)	100%	134%	149%	181%	166%	277%
Australian Zn Production indexed (1953 = 100%)	100%	134%	193%	287%	354%	513%
Australian Cu Production indexed (1953 = 100%)	100%	241%	575%	683%	996%	2412%
Avg. grade Australian Pb ore mined (volume weighted)	10.6%	10.5%	7.0%	6.2%	4.6%	4.6%
Avg. grade Australian Zn ore mined (volume weighted)	10.7%	10.6%	8.5%	9.1%	8.6%	8.3%
Avg. grade Australian Cu ore mined (volume weighted)	1.2%	1.6%	1.6%	2.2%	2.5%	1.1%

Figure 7. Production and grade of Pb, Zn and Cu ores in Australia [10].

This fact brings several challenges for the mining companies to develop new technologies to improve the exploration but also to deal with the low-quality ores in the existing processing operations.

These challenges are interrelated with other sensitive areas like energy consumption and waste management.

2.2 Environmental Challenges

Mining companies have ever faced environmental scrutiny from the communities where they operate however the standards are getting more and more strict every year.

The environmental issues also changed over the years. While acid rain and effluent treatment were the key concerns a few decades ago, topics like carbon emissions and waste management have become a priority recently.

Technologies to address these topics are available but the industry has still a long way to go to make then available in large scale. The lack of action to develop these technologies will certainly impact the relationship between companies and communities and their license to operate.

2.3 Increasing Energy Costs

The mining industry is intrinsically energy intensive. The main challenges are driven by the need to reduce cost due to the rising price of energy but also to change the energy matrix to renewable sources.

This last topic is reinforced by the carbon tax and the carbon cap-and-trades schemes currently under discussion in several international forums. These schemes have the potential to increase energy costs even further.

The cost for renewable energy is reducing but their availability is still an issue for the industry. The reliability is also another area requiring further development.

2.4 Automation

The term fourth industrial revolution, or Industry 4.0, is becoming very popular in the last years. It refers to the use of information technology and/or artificial intelligence to develop solutions for the industry.

The use of these technologies covers the entire life cycle of the mine, from exploration to production, including transportation and environment monitoring. Although the innovation in the mining industry has been relatively flat, the number of patents related to automation has increased significantly [11] as shown in Figure 8.

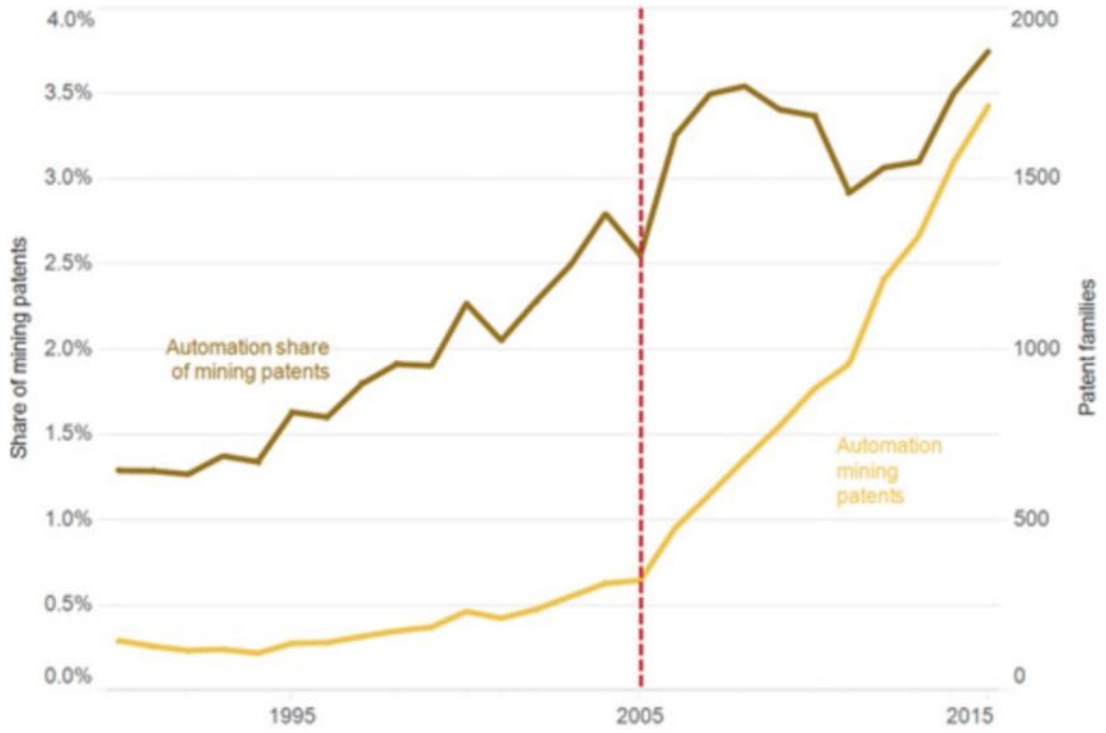

Figure 8. Patents related to automation in the mining industry [11].

Automation is not the core business of mining companies, and they usually have few specialists in the area. It does mean the companies need to cooperate with other companies, in many case start-ups, posing a challenge to the current operating model of developing R&D in the mining industry.

3. Conclusion

Most of the challenges faced by the mining companies are wicked problems and requires cooperation to be addressed in sustainable way. The cooperation can take several forms: between competitors in some areas with common problems, between companies and specialized suppliers, between companies and start-ups in non-core areas and between companies and external R&D institutions, public or private, to mention just a few.

The cooperation has several benefits which we can mention a few:

- Sharing the development cost
- Increase of experts' pool available for the projects

- Development of specialists in critical areas for the companies
- Development of finance mechanism to support emerging high-tech companies

However, the cooperation requires a change in the mindset currently dominant in the industry. The companies need to revise their future R&D budgets to seriously address the challenges. The internal R&D departments must be strengthened, or even rebuilt, and the relationship with other R&D partners must be included in the strategic plan.

Although cooperation is critical for the success of R&D in the mining industry, the formula is different for each company. The R&D strategic plan must be aligned with the business strategy to deliver the expected outcomes.

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