The Future of the Mining Sector

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1. Introduction

The mining sector in South Africa has long been a vital component of the country's economy, generating large amounts of income and employment. Over the years we have noticed significant dominance of technology within the mining sector, leading to the advancement of systems that existed in the sector and the introduction of new systems that never existed in the sector. Technology has become the problem-solving mechanism of the sector since it provides practical solutions to the constraints that the mining industry is facing which affects production, efficiency, sustainability, safety, expenses (in terms of reducing costs), and more. The digital transformation introduced by technology goes beyond limits as it tends to make what is said to be unfeasible by us human beings feasible, especially in areas where human beings cannot afford to go underground due to safety reasons.

2. Emerging technologies in the mining sector include the following:

2.1. Drones.

(a) **Stockpile management**: Placement and volume of stockpiles can be accurately predicted with mine aerial surveying. This information helps in producing better inventory and financial data along with improved data for weekly or monthly management.
(b) **Monitoring and operation planning**: Imagery of drones can accurately estimate any volume of material needing to be removed from mine sites in compliance with plans or legal standards like sediment flow and creating water, or monitoring tailings dam levels remotely.
(c) **Automatic surveying and mapping**: Mapping mineral landscapes and surveying is a quicker process using a drone.
(d) **Haulage road optimization**: The efficiency of mining applications is dependent on the haulage road networks. Road conditions must be monitored consistently for safety.
(e) **Assessment before and after drilling or blasting**: Drones produce cost-effective and accessible 3D reconstructions as well as surface models to display the drilling or blasting site area in mining.

(f) **Hazard identification and mitigation**: Safety is prioritized on any mine site, and drone surveying can easily spot any safety hazards with its high-resolution images.

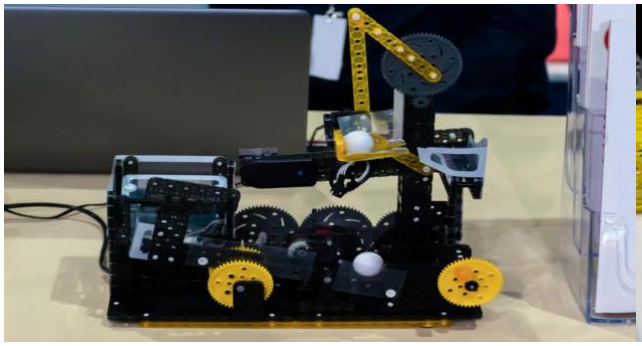
(g) **Tailings dam management**: Drones surveys are used for measurement by managers of tailings dams, and eliminate the risk associated with manual surveying.

(h) **Mining exploration**: The use of drone survey imagery supports mining exploration, especially in site areas where it is difficult to navigate by foot.


3. 3D Printing

3.1. 3D printing is employed in the mining sector for:

a) 3D printing technology has the potential to completely transform the mining sector by allowing on-demand fabrication of mining tools and equipment. This technique can be utilized to produce replacement components for machinery rapidly and affordably, decreasing downtime and increasing productivity. Lastly, the time and expense of building could be significantly decreased if whole mining buildings, including subterranean(underground) tunnels, were to be constructed using 3D printing technology in the future.




4. Automation

4.1. Automation is employed in the mining sector for:

a) **Safety**: Automating certain processes can help to minimize staff in hazardous work areas or remove staff completely while reducing the risk of accidents and fatalities. Through automation, potential legal issues associated with workplace accidents can be prevented as well as costly downtime.
b) **Monitoring**: With automation, mining equipment is monitored meaning tests can be run so that problems that are likely to arise can be detected early before they occur.
c) **Productivity and Efficiency**: Automated systems can operate at all hours without the need for breaks, allowing for continuous production. Data can be analysed in real time for adjustments, leading to a more efficient operation.

d) **Sustainability**: Energy consumption is optimised meaning automation can help by reducing water consumption which impacts the environment. Automation serves as an ongoing effort to review the industry and how it can meet regulatory requirements for environmental protection and sustainability.

5. GPS Fleet tracking

5.1. GPS Fleet tracking is employed in the mining sector for:

(a) **Maximum protection of cargo**: The use geo zones make sure that cargo does not leave the specified territory and weight load sensors always know the exact weight.
(b) **Efficient cargo delivery**: Accurate tracking data and getting information instantly even when the GSM network is unavailable makes this possible so that mining companies can maximise fleet efficiency.

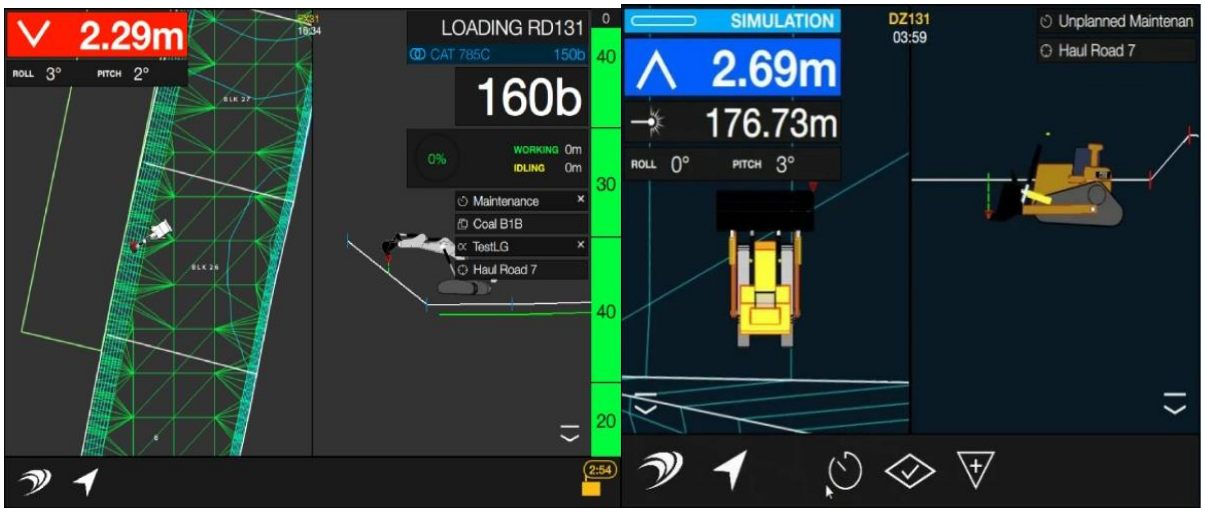
(c) **Custom geofencing capabilities**: Virtual boundaries are set to receive instant notifications when vehicles do deviate from pre-defined routes or moves towards restricted areas to ensure compliance with safety protocols and efficient route management.

(d) **Detailed operational insights**: Valuable insight is gained into idle times, vehicle usage patterns and driver behaviour while optimising operations and increasing productivity.

(e) **Preventive maintenance planning**: Tracking of vehicle health and usage with cloud leads to proactive plan maintenance, reducing downtime and extensive life of mining fleet.

(f) **Improved safety standards:** Driver behaviour is monitored to ensure compliance with safety regulations to reduce the risk of accidents in challenging mining environments.

(g) **Cost-effective fleet management**: This is effective by optimising routes, reducing idle time and proactively managing.



6. Cloud

6.1. Cloud is employed in the mining sector for:

(a) **Safety**: with cloud, risk arising from environmental hazards harming workers are mitigated as sensors and data analysis can identify the risks of catastrophic events like structural collapse or rather dam failure early so that personnel can be evacuate in time through monitoring data like piezometric pressure, inclinometer readings and pond elevation. Worker health can be monitored by companies to anticipate stress and fatigue. Personal health markers can be captured using wearable Internet of Things

(IoT) equipment to make decisions that will retain workers in optimal conditions. Cloud enables dangers such as dust, UV rays, chemical exposure and excessive noise to be monitored and be managed.

(b) **Productivity**: The uptime of equipment can be increased. Analytics on health data provided by cloud-connected sensors on machinery (such as conveyors and mills) can notify operators in advance of faults and failures and recommend preventive actions. Models of digital twin equipment provide fresh perspectives on ideal usage procedures and various use cases. Cloud-based mining companies can enhance their communication efficiency with external partners in their supply and industrial chains, resulting in stronger business ecosystems and increased productivity. Real-time production and operating status displays are available to miners. Every partner has access to the information required to support their cooperative duties, including equipment upkeep, mine planning, resource transportation, supervision, consulting, and research.

(c) **Environmental, Social and Governance**: The ability to access environmental data more readily means that decisions can be made more appropriately. Reports and best practices on resource management can be made available to all employees on a cloud portal. The ability to live in cities and fully engage in family and social life is one of the benefits of moving on-site jobs to remote operations centres; these advantages are thought to be more beneficial to worker wellbeing than even the most generous amenities available on a remote site.

7. Conclusion

We as SAMYA are concerned about the skill development that our curriculum lacks in this fourth industrial revolution. The future of mining seems to be inclusive but demands relevance. We call upon the Government, Engineering Council of South Africa, Mining Qualifications Authority, and South African Institute of Mining Metallurgy to work with us and try to fill in the gap between our curriculum and skill development for the benefit of our youth. We are concerned about the number of young graduates who graduate and thereafter have no impact on their own country due to a lack of necessary skills to invest in their country and uplift themselves. The time to merge our curriculum and technology has come and we believe that our youth will do wonders if

they are to be given necessary skills as they are already invested in technology. Lastly, we invite the companies to come forward and work with and fill the gap.