Mark Dougan
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The Future of Mining and Agriculture

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Frost & Sullivan
28 Nov 2017
MINING

6.9% of GDP (2016-17)
Contributed to 14% of GDP growth over the past decade

Mining Reserves: Australia’s Global Ranking

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Iron Ore, Gold, Zinc, Nickel, Uranium</td>
<td>Bauxite, Copper, Brown Coal</td>
<td>Black Coal</td>
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</tbody>
</table>

AGRICULTURE

2.6% of GDP (2016-17)

Australia in World Top-10 Largest Producers of:
Wheat, Barley, Almonds, Sugar Cane, Cotton, Wool, Beef, Lamb

Source: Dept of Industry Innovation and Science, ABARES, Frost & Sullivan
The Future of Mining
Sector Trends Impacting Opportunities

- Declining ore grades
- Increased supply competition from emerging countries
- Price volatility
- Sustained long-term demand for commodities
- Increased compliance costs
- Focus on non-traditional commodities
- Increased energy security risk
- Leverage of digital technologies

Source: Frost & Sullivan
Expanding the Mining Footprint

Emerging Markets with Top 15 Reserves by Size in at Least One Commodity, Global

- **Cuba** — Ni
- **Guyana** — Bx
- **Jamaica** — Bx
- **Suriname** — Bx
- **Venezuela** — Bx, IO
- **Colombia** — Ni, PGM, Coal
- **Congo** — Cu, Dia
- **Zambia** — Cu
- **Botswana** — Dia, Ni
- **Guinea** — Bx
- **Ghana** — Au
- **Kazakhstan** — Bx, Cu, IO
- **Uzbekistan** — Au
- **Mauritania** — IO
- **Madagascar** — Ni
- **Iran** — IO
- **India** — Bx, IO, rE, coal
- **China** — Bx, Cu, Dia, Au, IO, Ni, rE, coal
- **Vietnam** — Bx
- **Indonesia** — Cu, Au, Ni
- **Russia** — Bx, Cu, Dia, Au, IO, Ni, rE, PGM, coal

Source: Corporate Exploration Strategies; Frost & Sullivan
Digital Transformation in Mining

Cloud allows access to content on any device in any location.

Internet of Things

Low-cost sensors using apps in the cloud and big data are becoming more powerful.

Mobility

Mobility drives the emergence of apps that can be used on any IP-enabled device.

Digital Transformation

Big data enables value extracted from an exponential increase in data. Data from IoT to be analysed. Focus areas: Robotics, drones, cognitive computing/AI.

Big Data/Al

Source: Frost & Sullivan
Drivers and Restraints

Inadequate budget reduces market penetration and weakens overall revenue growth
Inadequate understanding and appreciation of digital transformation benefits continue to hamper market development

Need to reduce costs prompting exploration of digital solutions
Need for increased operational agility and efficiency
Need to mitigate risks and ensure compliance

Source: Frost & Sullivan
**Industrial IoT’s Role in Resolving Challenges**

- Flexibility to adapt to market needs
- Quick access to knowledge experts and documents
- Integrated value chain
- Environmental standards
- Track and trace
- Easy access to data
- Focus on customisation
- Production efficiency
- Product innovation – Remain competitive

**IIoT Technologies (IT and OT convergence)**

- **Smart Sensors**
- **Drone Technologies**
- **Autonomous Vehicles**
- **Process Simulation**
- **Robotics**
- **Cloud Computing**
- **Big Data & Analytics**
- **Predictive Maintenance**

Well over 1 million IoT sensors and devices in fixed plant in Australia’s mining sector

Source: The University of Sydney and Frost & Sullivan
Digital Transformation across the Chain

**Exploration**
- Real-time geospatial data available on the Internet

**Mine Design, Planning & Development**
- Onsite lab to analyse drilling fluids for informed decision-making, including characterising the extent and locations/trajectories of drill holes

**Extraction**
- Dynamic, real-time modelling software, readily updated with new information. Ensures accurate decision-making by eliminating version control issues

**Processing**
- Machine-learning algorithms to predict future outages in processing assets
- Smart sensing for bulk sorting of waste from ore making marginal, low-grade sites viable

**Transport & Logistics**
- Smart cameras and algorithms for driver fatigue detection
- Sensors for conveyor monitoring where roller rotation powers the device

**Trade**
- Online portal allowing vessel operators to participate in e-auctions direct for miners
Drones in Mining

Current Use Cases

- Aerial 3D mapping for volumetric measurement of aggregates
- Slope inspection and characterisation, highwall mapping
- Infrastructure and equipment inspection (Smelter stacks, Railroads, railcars, Pipelines, Overhead power lines and substations)
- Blast monitoring and post blast surveys
- Incident investigations and emergency response

Future Direction

- Increased flight times
- Use underground and in confined spaces
- Real-time video and data streaming
- Use of machine learning

Source: Frost & Sullivan
What will the focus areas be in the future?

Significant opportunity to widen the application of **sensors** across the mining value chain.

Significant potential for **drone-as-a-service** business models for the mining sector.

Untapped opportunities to transform the rich data sets generated from mines into actionable insight using **AI**.

**Cybersecurity** will become increasingly important as connectivity expands the attack surface.

Source: Frost & Sullivan
The Future of Agriculture
The Challenge Ahead

Per Capita Food Consumption, 2015–2030

Developed Countries
Transition Countries
World
Developing Countries

Kilo-calories (kcal) per person per day

Year
2015
2030

Per Capita Growth in Food Consumption (kcal/person/day)

2,940
3,050

+3.7%

Decline in Arable Land (Hectares/person)

2015
0.202
(4.4%)
2030
0.193

Not a re-distribution problem—
“Even if we took all the food produced in 2009 and distributed it evenly amongst the global population, the world will still need to produce 974 more calories per person per day by 2050.” - World Resource Institute

Source: Frost & Sullivan
Enabling Technologies for Future Farms

**Hardware**
- Precision agriculture equipment
- Crop cultivation technologies
- Sensors and sensor fusion
- GNSS equipment
- Autosteering/automation technologies

**Software**
- Farm operations Management solutions
- Predictive analytics
- Controlled traffic farming software

**Service Requirements**
- Installation and systems integration
- Yield monitor calibration
- UAV drone mapping

**Communication**
- GNSS (includes all satellite-related solutions such as tractor guidance, auto steering, and yield monitoring)
- Cellular
- LPWAN

**Others**
- Cloud computing
- Machine-to-machine (M2M) communication
- Artificial intelligence

Note: GNSS—Global Navigation Satellite System
LPWAN—Low-power Wide Area Network

Source: Frost & Sullivan
Disruptive Technologies - Emerging Use Cases

Soil and Water Monitoring
Grain Silo Monitoring
Hot-house (Greenhouse) Condition Monitoring
Cattle Tracking

Nutrient Sensing Technologies
Weather and Climate Sensors
Aeroponics
Hydroponics/Aquaponics

Variable Rate Technologies
Autonomous Farming
Agriculture Drones
Robotics

Source: Frost & Sullivan
Connectivity – Creating New Business Models

Tractor-as-a-service helping farmers shift CAPEX cost to OPEX

• Farmers are discovering the option to pool their vehicles and machinery to share the cost of ownership using a tractor-as-a-service model.

• Opportunity to go beyond tractors - platform that lets farm co-ops, equipment retailers, and dealers pay for equipment on demand and rent out their own machinery when not in use.

Source: Frost & Sullivan
• **Remote sensing** maps every field in the US and superimposes climate information.

• Database contains over 150 billion soil observations and 10 trillion weather-simulation points.

• Result is **prescriptive planting** according to the weather.

• **Model pushed up yields** by about 5% over two years.

• Monsanto is now **selling insurance** to farmers through independent agents.

Source: Monsanto; Frost & Sullivan
Thank You