MINING LEARNING SERIES

Future Mining: Automation, AI & Drones

Connected technology, safer decisions and new mining careers

Prepared by FundaWay Team

How to Use This Study Note

Read one section at a time, write down unfamiliar terms, explain each process in your own words and then complete the revision questions without looking back.

LEARNING OUTCOMES

After studying this guide, you should be able to: distinguish automation, autonomy and remote operation; explain how sensors and data support mining; describe AI, drones, robotics and digital twins; identify cybersecurity and ethical risks; connect digital-mining careers to school subjects.

QUIZ PREPARATION

The matching FundaWay topic quiz contains 20 questions. Focus on understanding cause and effect, safe practice, calculations and correct technical vocabulary.

1. What Is Future Mining?

Future mining uses connected digital systems, automation and better data to improve safety, productivity, environmental performance and decision-making. Technology supports people; responsible design keeps people accountable for important decisions.

- Sensors measure conditions and equipment health.
- Networks move data between machines, control rooms and teams.
- Software analyses patterns and supports decisions.
- Automation carries out defined tasks with less direct exposure to hazards.

KEY IDEA

A smart mine combines people, process and technology. Buying technology without training, maintenance and clear responsibility does not create a smart mine.

2. Automation and Remote Operation

Automated equipment follows programmed rules, while autonomous equipment can sense conditions and make limited operational decisions. Remote operation lets a trained person control equipment from a safer location.

System	Main benefit	Important control
Remote drilling	Less exposure at the face	Reliable video, controls and emergency stop
Autonomous haulage	Consistent movement	Separation zones and obstacle detection
Remote inspection	Access to risky areas	Qualified review of collected evidence

HUMAN OVERSIGHT

Automation changes work; it does not remove the need for competent supervision, safe procedures and clear stop-work authority.

3. Sensors, IoT and Real-Time Data

The Internet of Things connects sensors, machines and software. Underground sensors can measure gas, airflow, vibration, temperature, location and equipment condition.

- A sensor converts a physical condition into data.
- A gateway or network carries the data.
- A dashboard presents alerts and trends.
- A response procedure tells people what action to take.

> **DATA QUALITY**
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> A wrong, poorly placed or uncalibrated sensor can produce misleading information. Critical alerts need testing and maintenance.

4. Artificial Intelligence and Predictive Maintenance

Artificial intelligence can identify patterns in large datasets. Predictive-maintenance models use measurements such as vibration, temperature and oil condition to estimate when equipment may fail.

- Benefit: planned maintenance can reduce breakdowns and unsafe failures.
- Limit: a model can be wrong if its data is incomplete, biased or no longer representative.
- Good practice: combine model output with inspections, engineering judgement and maintenance history.

> **RESPONSIBLE AI**
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> High-risk decisions need human review, traceable data and a safe fallback when systems fail.

5. Drones, Robotics and Digital Twins

Drones can survey pits, stockpiles and inaccessible areas. Robots can inspect confined or unstable spaces. A digital twin is a digital representation of a physical asset or process that updates with data.

Technology	Useful task	Key risk
Drone	Mapping and inspection	Airspace, weather and privacy
Robot	Hazardous-area inspection	Loss of control or communications
Digital twin	Testing scenarios	Model assumptions may be wrong

RULE

Technology must be used by competent people under site procedures and applicable law.

6. Cybersecurity and System Resilience

Connected mines face cyber risks. A compromised account, device or control system can interrupt production and may create a safety hazard.

- Use strong authentication and least-privilege access.
- Keep systems updated through controlled change management.
- Separate critical operational systems from general networks.
- Back up essential data and test recovery plans.
- Report suspicious messages, devices and system behaviour.

> **STOP AND REPORT**
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> Never connect an unauthorised device or bypass a security control to save time.

7. Skills and Careers for a Digital Mine

Future mines need engineers, artisans and operators who understand both physical equipment and digital systems.

- Possible careers: automation technician, mechatronics engineer, data analyst, drone operator, cybersecurity specialist and control-room operator.
- Useful school subjects: Mathematics, Physical Sciences, Information Technology and Engineering Graphics and Design.
- Human skills remain essential: communication, ethical judgement, teamwork, curiosity and continuous learning.

> **CAREER TIP**
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> Build a portfolio through safe school projects: sensor experiments, coding, data visualisation, robotics or maintenance problem-solving.

Key Terms

Term	Meaning
Automation	Technology performing a task according to programmed rules.
Autonomous system	A system that senses conditions and makes limited decisions within defined boundaries.
IoT	Connected sensors, devices and software that exchange data.
AI	Computer methods that identify patterns or produce outputs from data.
Predictive maintenance	Using condition data to estimate when equipment may fail.
Digital twin	A data-linked digital representation of a physical asset or process.
Cybersecurity	Protecting systems, networks and data from misuse or attack.
Human oversight	Meaningful review and control by competent people.

Revision Questions

Answer in full sentences before checking the memorandum.

- 1. How does remote operation reduce exposure?
- 2. Give two examples of mine sensor data.
- 3. What is one benefit and one limitation of predictive maintenance?
- 4. Why can a digital twin produce a poor decision?
- 5. Name three cybersecurity controls.
- 6. Which human skills remain important in a digital mine?

Answer Guide

- 1. It allows equipment to be controlled from a safer location.
- 2. Examples include gas, airflow, vibration, temperature, location and equipment condition.
- 3. It can reduce unplanned failure, but inaccurate or outdated data can make its prediction wrong.
- 4. Its model assumptions or input data may not match the real system.
- 5. Examples: strong authentication, least privilege, updates, network separation, backups and reporting.
- 6. Communication, ethical judgement, teamwork, curiosity and continuous learning.

READY FOR THE QUIZ?

You are ready when you can explain the key terms, apply the process steps to a new situation and justify safe or responsible choices without copying the notes.

References and Further Learning

These notes provide learner-friendly educational guidance. Mining technology and operating procedures change, so always verify current requirements with official institutions, employers, equipment manuals and regulators.

- Mine Health and Safety Council - research and safety guidance
- Department of Mineral and Petroleum Resources - regulatory information
- Council for Geoscience - geoscience and technology resources
- Official institution programme pages and manufacturer operating manuals

> **IMPORTANT**
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> This is a non-accredited learning resource. It does not replace mine-specific induction, legal training, professional advice or an official qualification.