Enabling Mines of tomorrow with AI

AI PHOTOGRAMMETRY: A CASE-STUDY OF TRANSFORMATIVE TECHNOLOGY IN THE MINING INDUSTRY

AI has the potential to transform mining

- Increased automation of data collection
- Rapid and accurate analysis
- Deeper, more relevant, insights
- Existing tools are being transformed
- Democratization of data
- Photogrammetry is a case-study

What is AI?

The ascending scale of computer technology:

Transistors - Calculation (passive)

Software - Algorithms (passive)

AI - Machine learning (active, recursive)

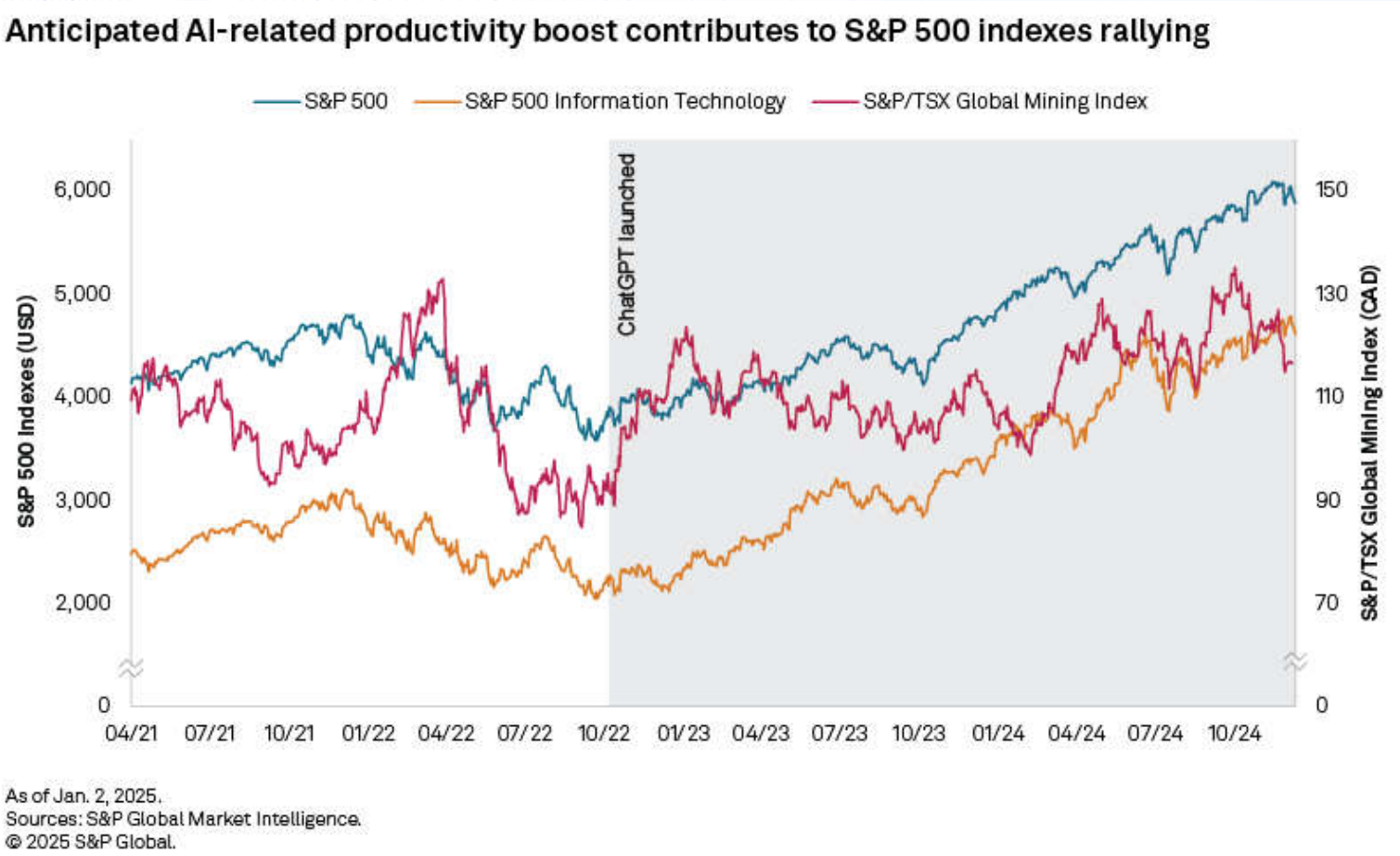
Simulated human-level intelligence

Problem solving, decision-making

How is AI Currently Used in Mining?

- Geologic interpretation
- Optimized exploration
- Blast performance
- Mining equipment operation
- Predictive maintenance
- Mineral processing

The AI ‘Boost’



As of Jan. 2, 2025.
Sources: S&P Global Market Intelligence.
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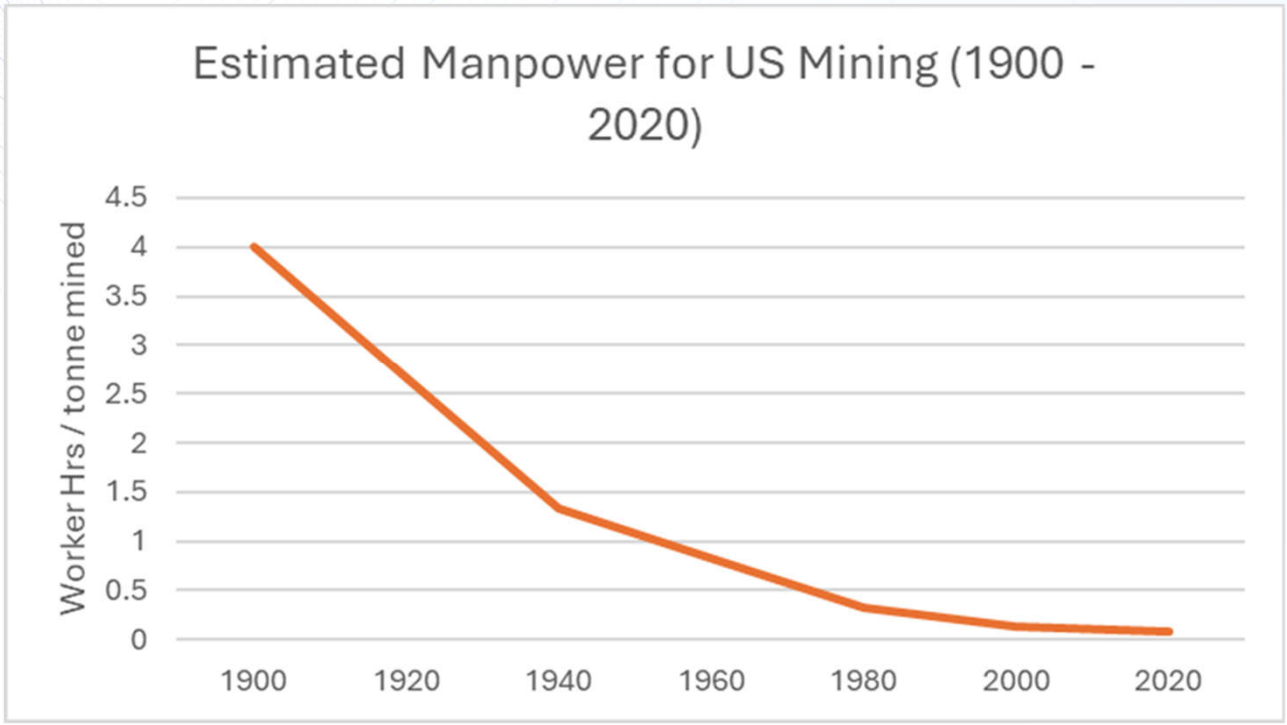
What is ‘Transformative Technology’?

A technology adopted, then adapted, with significant impacts.

- Water (‘lifts’, exploration, beneficiation, fragmentation)
- Steam (mechanized mining equipment)
- Large-scale Mechanization (widespread mobile equipment)
- Transistor (reproduction of information)
- AI (machine learning)

Mining is Ideally Suited for AI

Mining is driven to reduce manning, gather data



Historic data from USGS, EIA and Bureau of Mines, compiled by ChatGPT.

How Might AI Impact Mining?

- Equipment productivity
- Holistic planning
- Predictive mitigation in safety and compliance
- ‘Live’ link between mine and plant
- Predictive maintenance
- Deeper insights in planning

Photogrammetry: A Case-Study of Transformative Technologies

- A well-established tool
- Useful, but difficult to apply
- AI and other technologies = transformation into a new tool

What is Photogrammetry?

Most of us rely on photogrammetry without knowing it…..

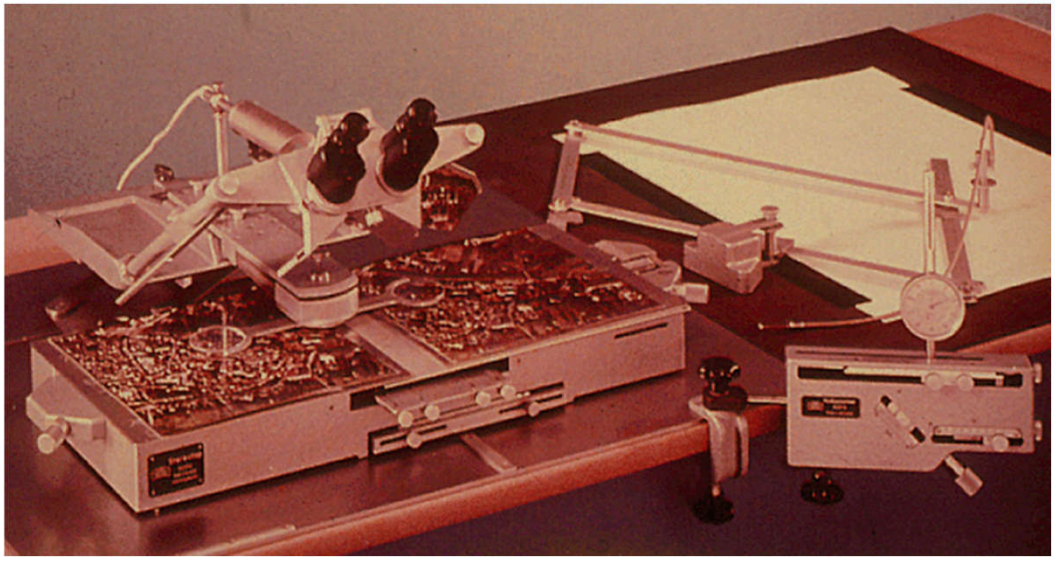
- Stereophotogrammetry = depth perception in human vision
- From…
  - Overlapping images
  - Common points
  - Position of camera
  - Trigonometry
- …elevations of common points.

History of Photogrammetry

- Terrain mapping, mid – 1800s
- 3D mapping, late-1800s
- World War 1, military reconnaissance

History of Photogrammetry (Cont…)

- 1960s on, analytic photogrammetry
- Computers used to speed process
- Cost, effort and convenience were a barrier through early 2000s
- Around 2010-2015
  - Commercial drones
  - Digital cameras
  - Cloud computing
  - Software



The Transformation of Photogrammetry

The process:

Collect - Analyze - **Share**

Transformation of '**Collect**'

- Commercial- and consumer-scale:
  - Drones
  - Digital imaging

Transformation of '**Share**'

- Cloud-computing

The Transformation of Photogrammetry (Cont…)

The process:

Collect - **Analyze** - Share

- Transformation of '**Analyze**' is by AI
  - QA/QC of images
  - Enhanced feature detection = accuracy, inventorying
  - Accelerated processing
  - Compliance and change detection
  - Insight, analytics, indicators

The Transformation of Photogrammetry (Cont…)

Conventional Photogrammetry

- Expensive, inconvenient (manned aircraft, labor, specialized equipment)
- Manual, slow
- Expertise dependent
- Low accuracy

AI-Driven Photogrammetry

- Low-cost
- Rapid, automated
- Accessible
- Accurate

The Transformation of Photogrammetry (Cont…)

Conventional Photogrammetry

- ‘Special-case’ applications
- Hard to access areas
- Large-scale, long-term reconciliations

AI-Driven Photogrammetry

- Near real-time
- Short-range planning, daily
- Operations management

Example: Khavda Energy Park

- The largest renewable energy park in-construction in the world, (30GW)
- 500km2, 20M homes
- Land Surveying was not possible, constraining project
  - On the Ground: Marshy, access
  - In the Air: Cloudy, no satellite
  - Poor connectivity, data-jams
  - Enormous base of users, stakeholders

Example: Khavda Energy Park (Cont…)

Aereo, an Indian firm leading the field in transforming photogrammetry

Data Gathering

- Drones for high-frequency, precise, imaging

AI-Driven Data Processing

- Automated, rapid, accurate

Data-Sharing

- Cloud-based distribution and collaboration

Example: Khavda Energy Park (Cont…)

Data Gathering

- 100,000 Geotagged images / 2 weeks, high-precision
- 1 drone pilot replaced 5-10 survey crew for higher volume
- Greater availability in bad weather

Data Processing

- AI trained to detect drillholes, pilings, solar panels, construction feature, etc.
- 1M detections/cycle
- 5 days, >85% accuracy

Data Sharing

- Jams eliminated
- Reports customized to their user's need, immediate and direct

Conclusion: AI-Driven photogrammetry was transformed into the crucial tool for this job. Conventional surveying practically impossible.

Example: Coal India Ltd.

World's largest state-owned coal company, 700Mtpa, 70% of India's electricity

- >300 mines, widely dispersed
- CIL were 'flying blind'

So, launched the 'DigiCoal Initiative' - data-gathering for their 7 major assets, 250Mtpa

- 5M images processed with <2cm resolution
- 2800 custom reports to 400 stakeholders
- 6months total project time

Evolution of AI in Photogrammetry?

- Autonomous drones
- Survey areas, accuracy needs, timing could be ‘decided’ automatically and predictively
- Trend-based forecasting for greater efficiency
- Flagging safety / compliance problems
- Increased use of accurate ‘digital twin’ models

Conclusions

The **arc of technology** in mining:

- Reduce Labor - Generate Insights - **Better Decisions**

To understand AI in mining, useful to think **how tools will be transformed**

- Photogrammetry transformed from ‘special-case’ niche, to everyday operations-level management

Better decisions impact **economics**, **production**

- AI will irreversibly change how we manage our mineral wealth

