Dr. Greg Baiden
Mining Professor – Laurentian University
Chief Technology Officer – Penguin Automated Systems Inc.

LUNAR MINING
TAKING THE BEST OF TERRESTRIAL MINING AND FITTING IT TO THE MOON

Dr. Greg Baiden
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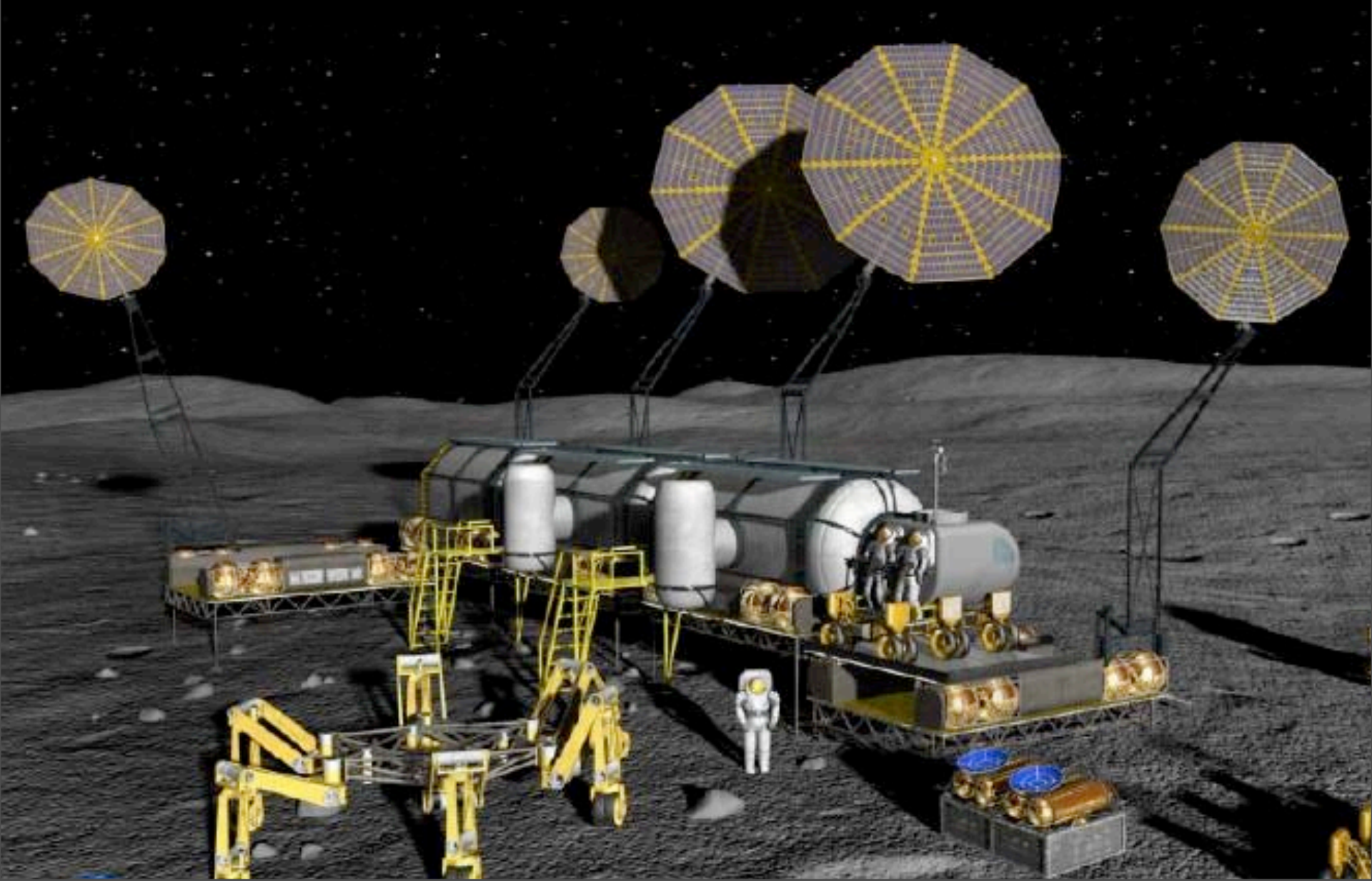
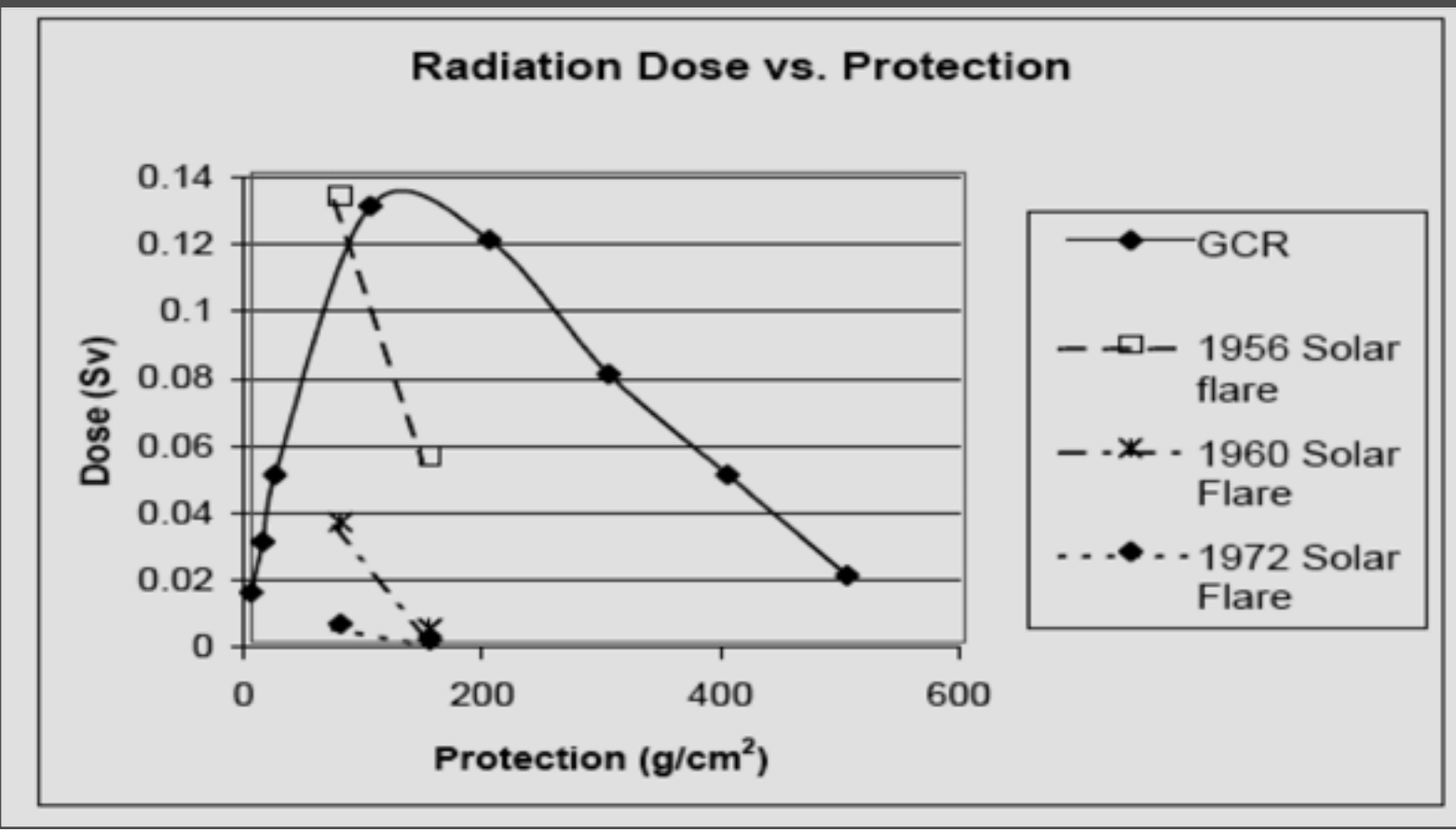
Chief Technology Officer – Penguin Automated Systems Inc.

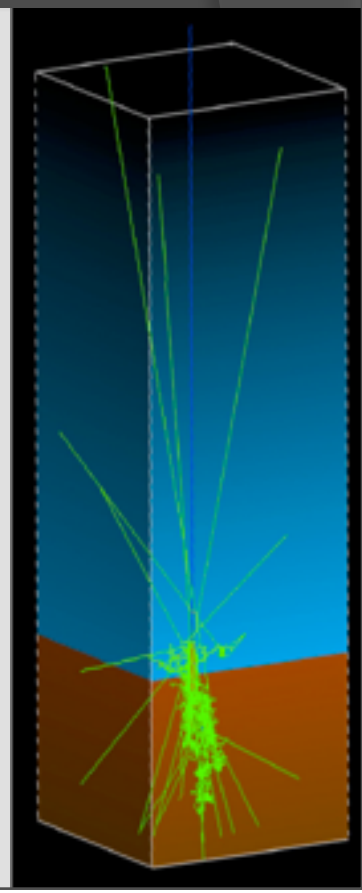
Baseline NASA Lunar Architecture (LAT2 – 2008)



Secondary GCR is a primary

- Galactic Cosmic Radiation is “The Showstopper” for long-term lunar exploration [Cohen, 1998]
- 80cm of Regolith cover *maximizes* the production of secondary radiation particles vs. surface exposure (which is where solar protons dominate the risk equation)





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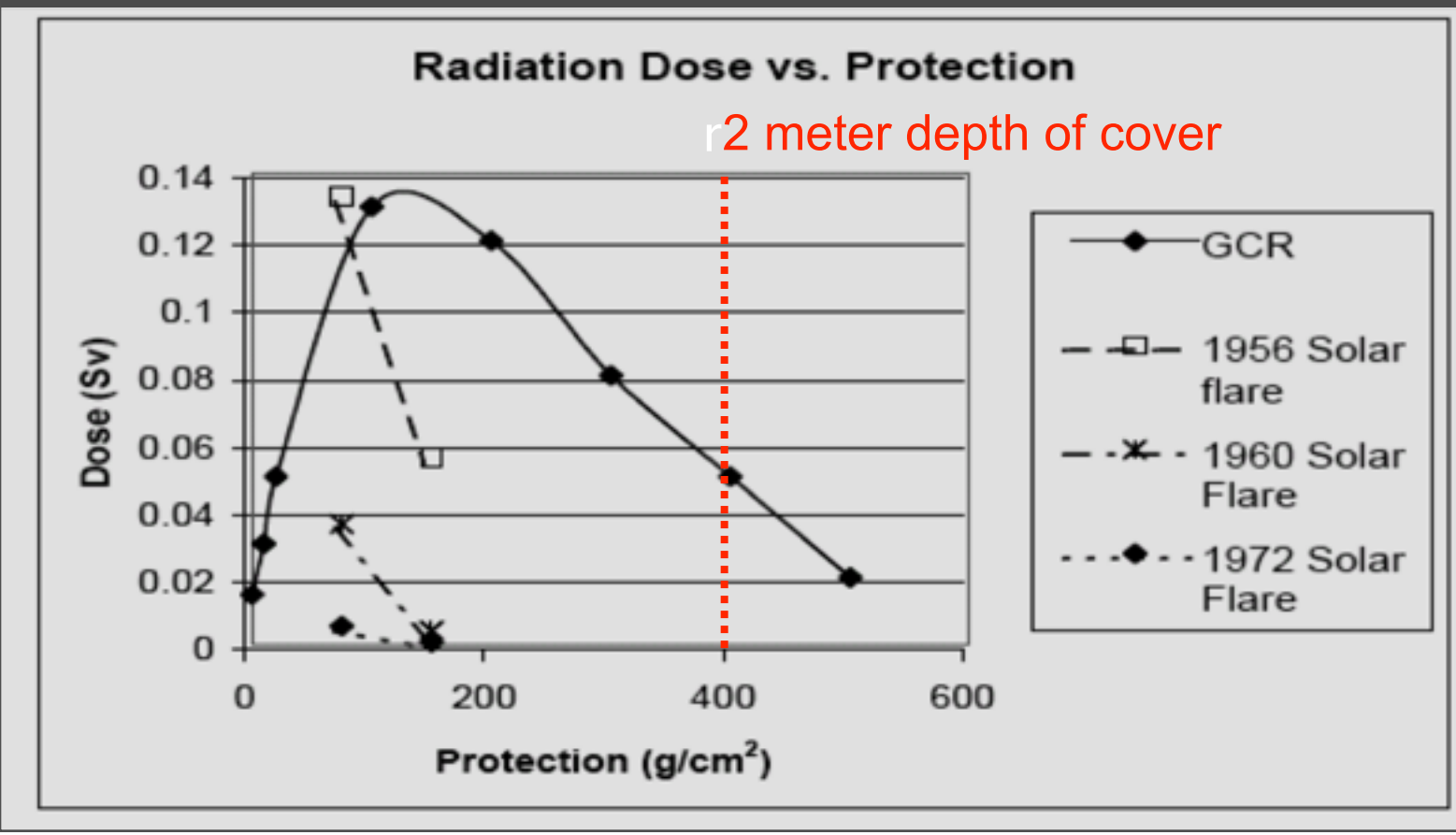
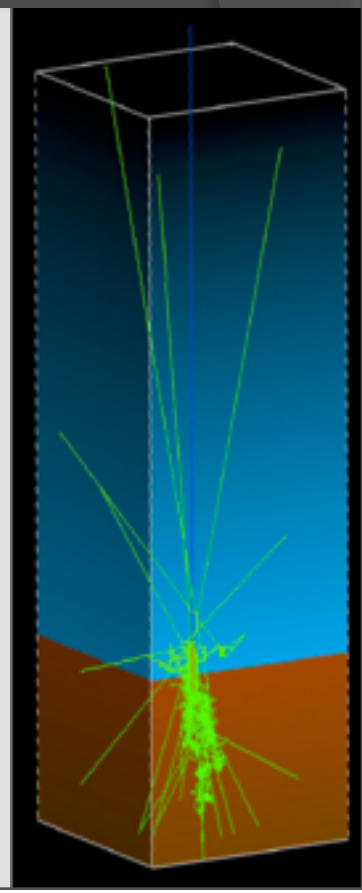
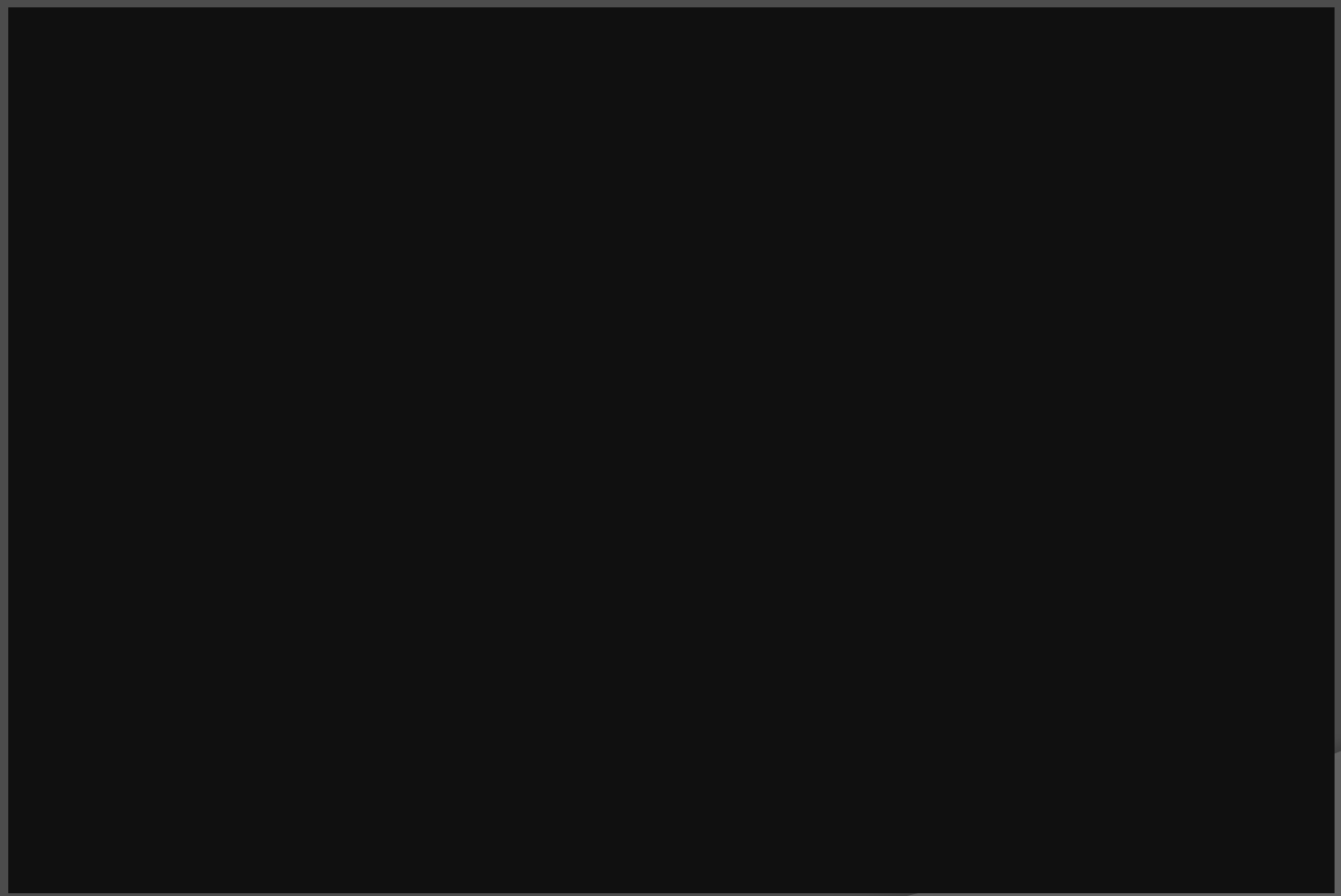




Lunar Mining leading to subsurface habitation

Either this or gravity



Mining Terms

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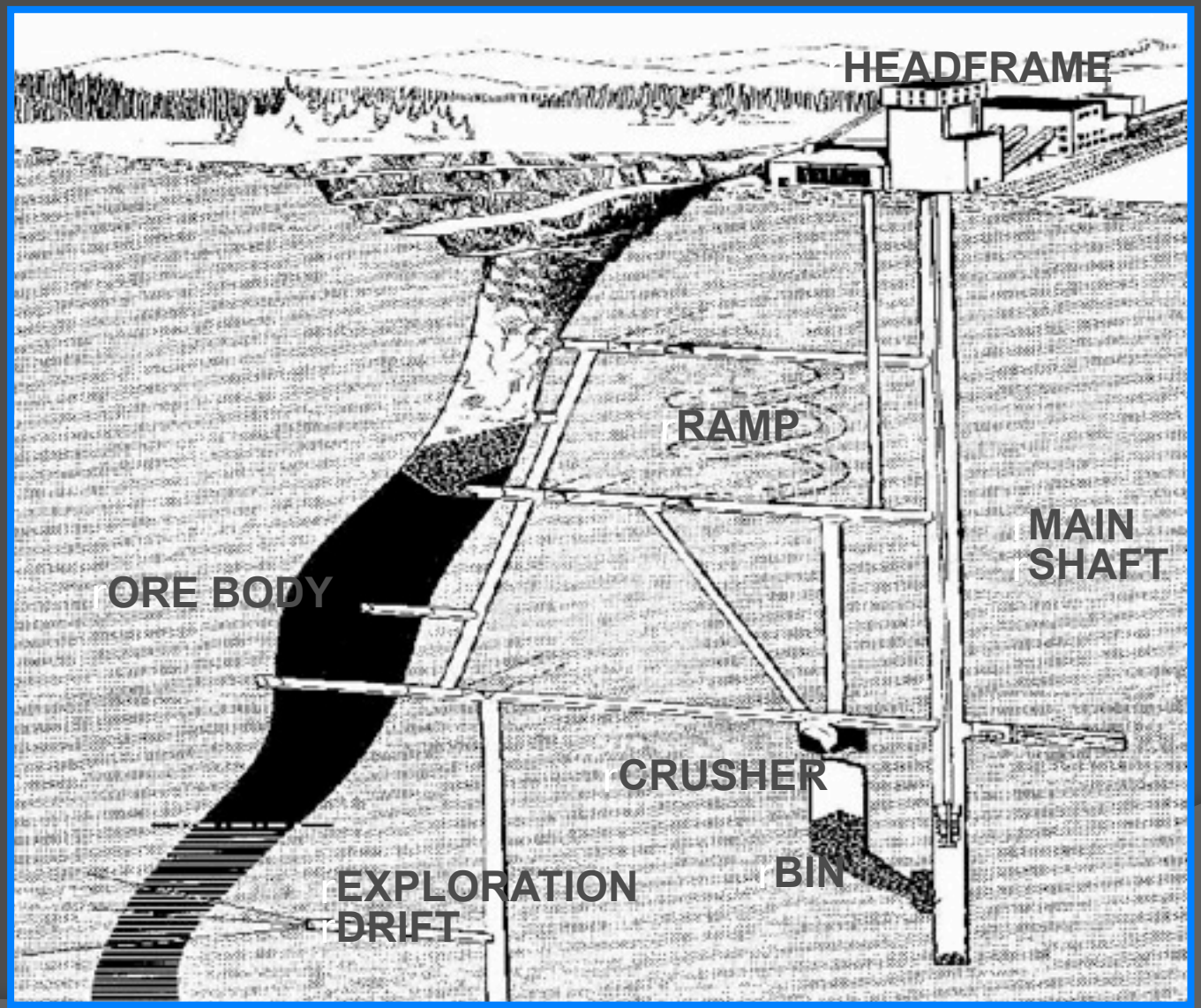
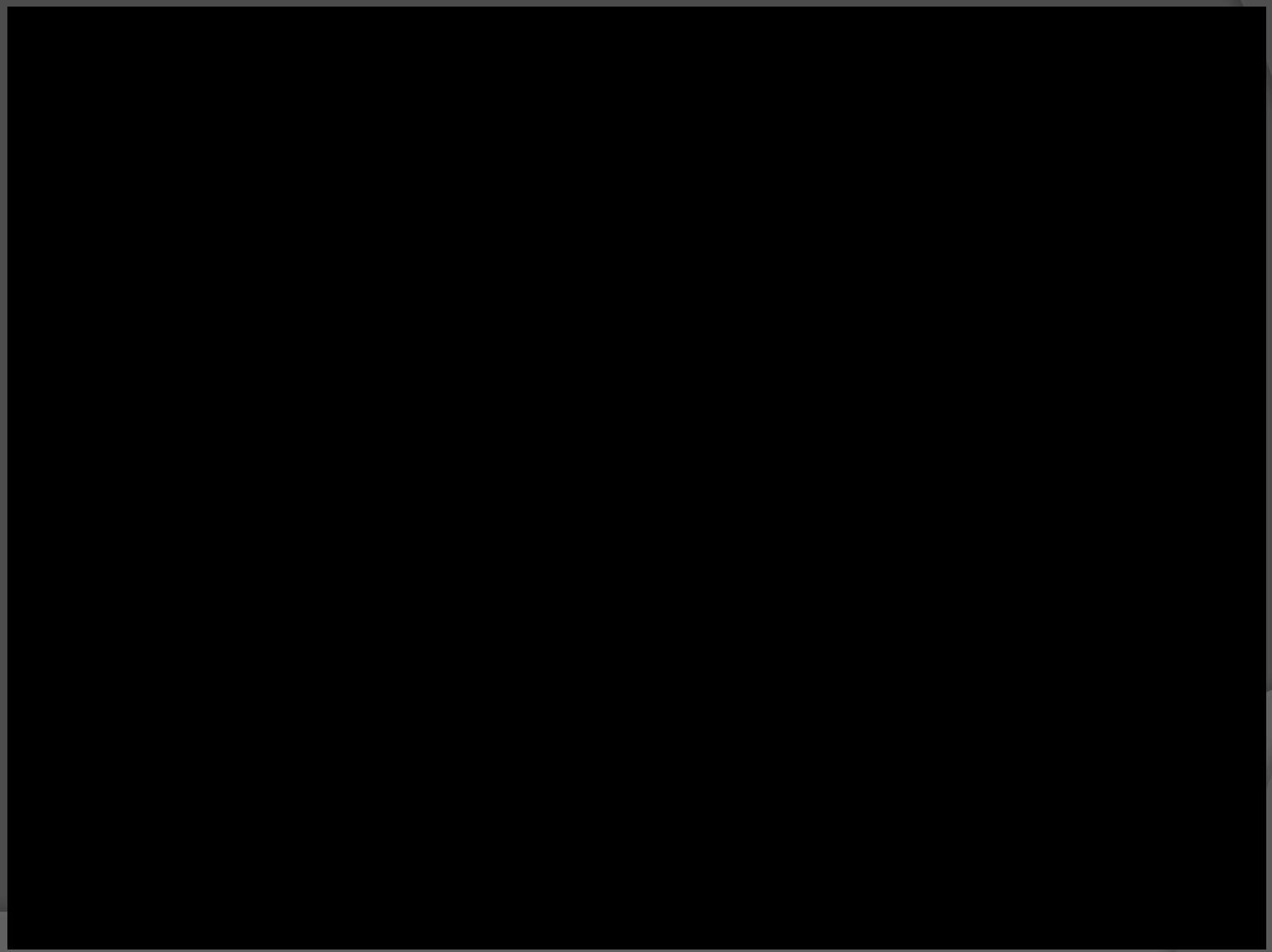


Design to Production



Automatic Haulage Truck -

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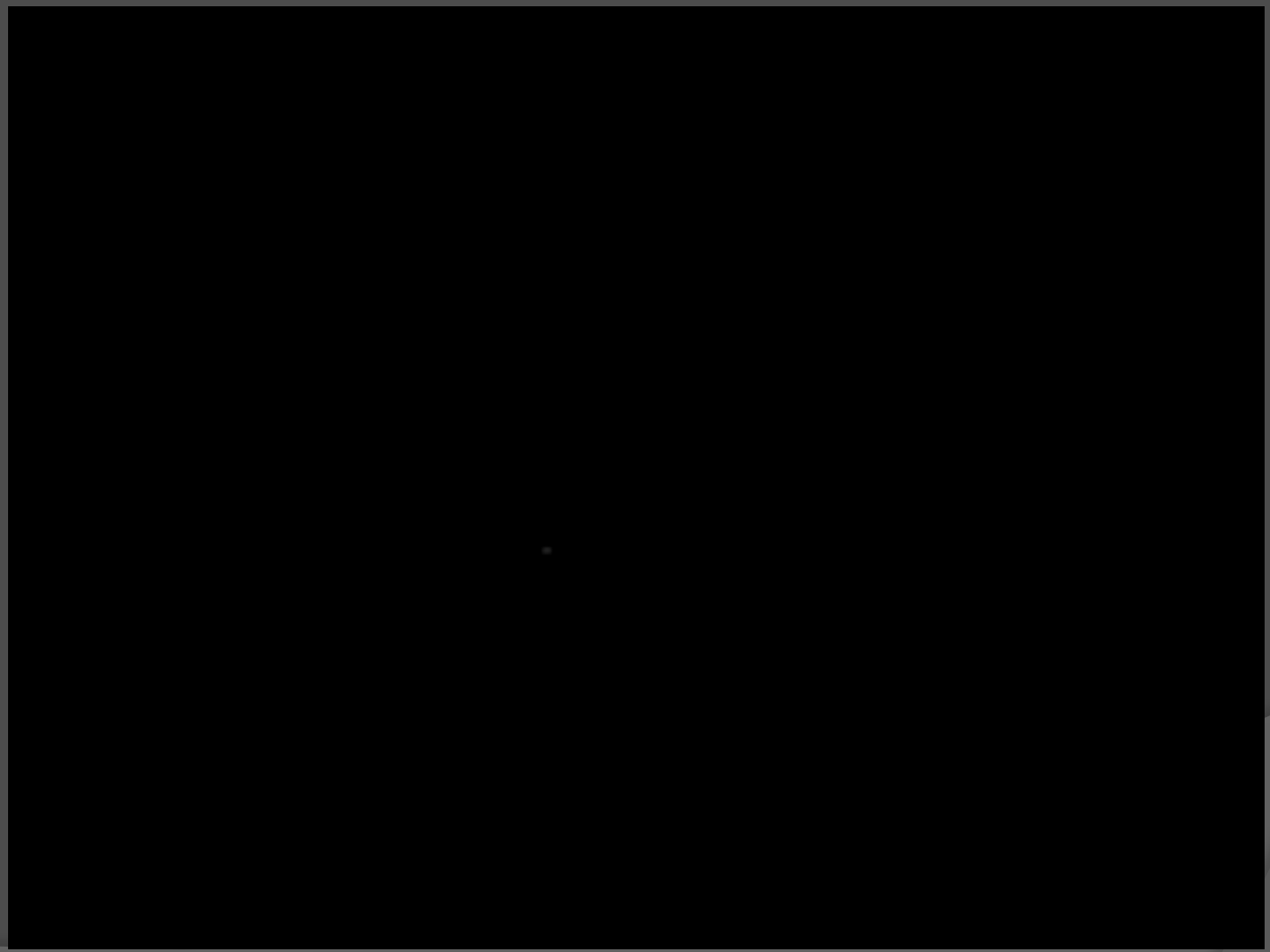
Mine Operation Center Technologies

Mine Operation Center Technologies



Telemining

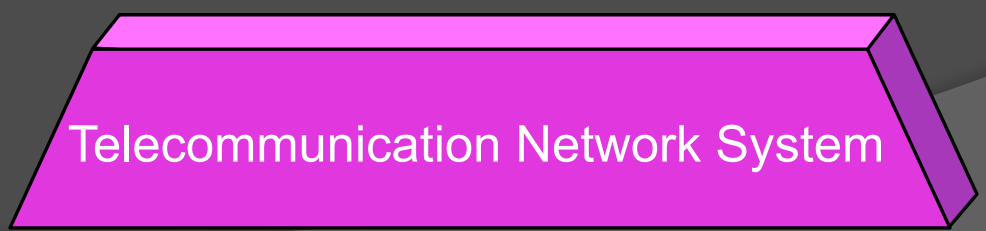
- Technology of robotics and the information age will change the face of mining terrestrially and extraterrestrially in the next century
  - Telerobotic mining
  - Safe, clean, efficient workplaces
  - High Tech Jobs

Telemining & Mining Plant

- Teleremote control of all our mining equipment
- Automation & Telemining allows enhanced mine value through:
  - mining rate increases
  - quality improvements

Key Technologies for

Key Technologies for



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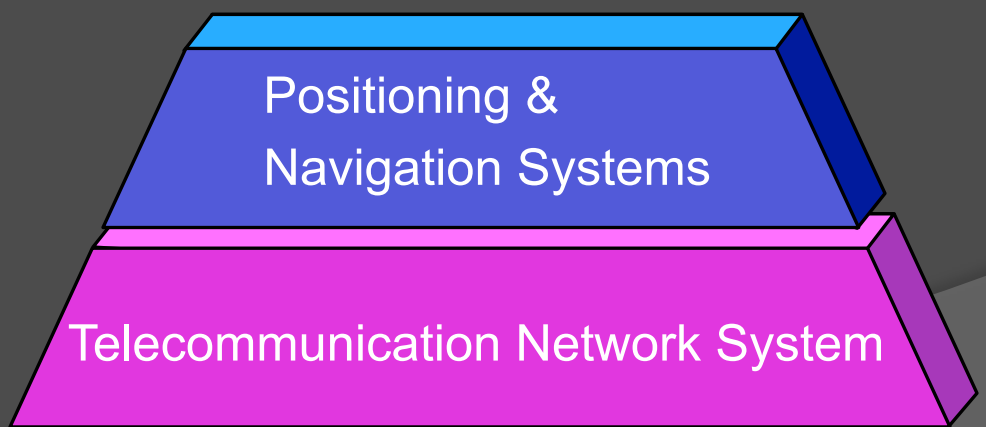

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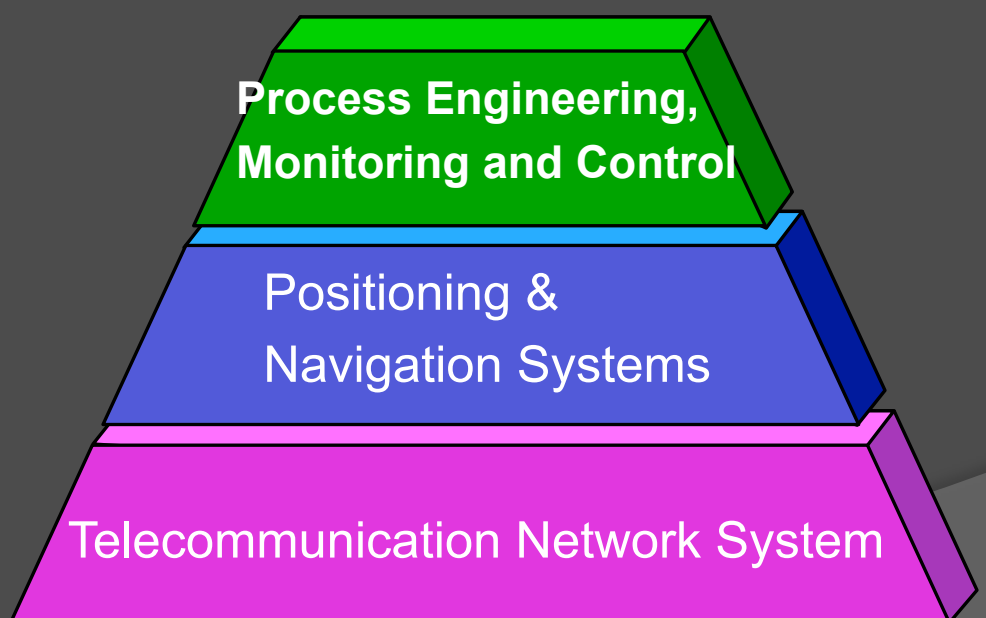

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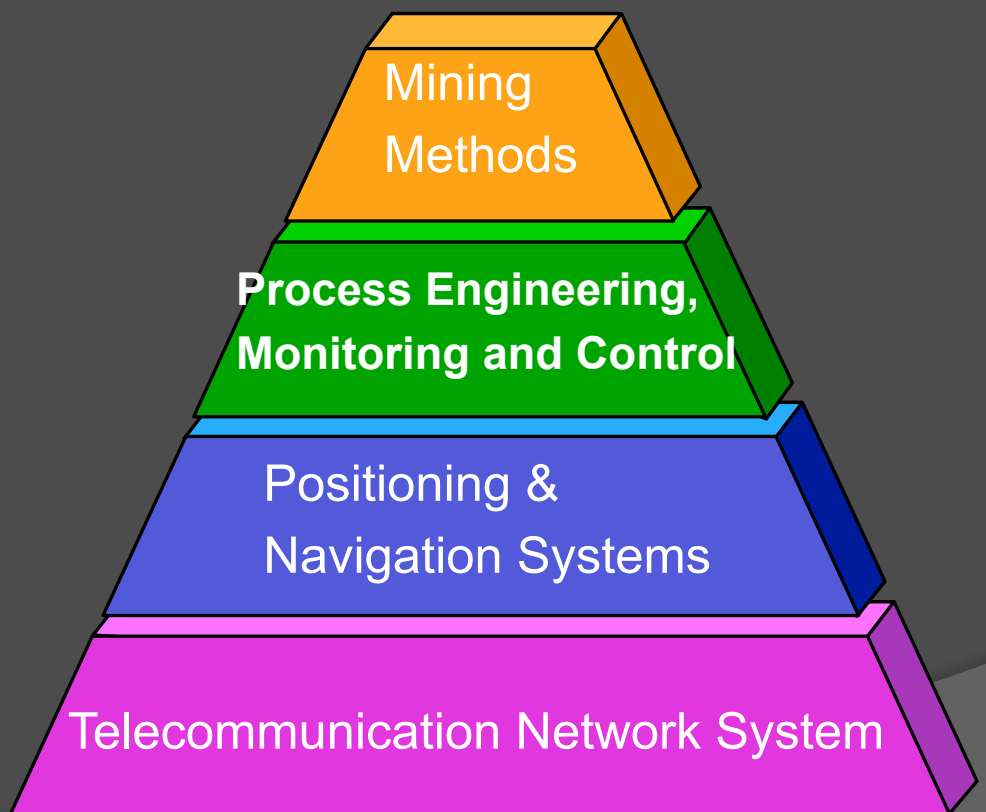

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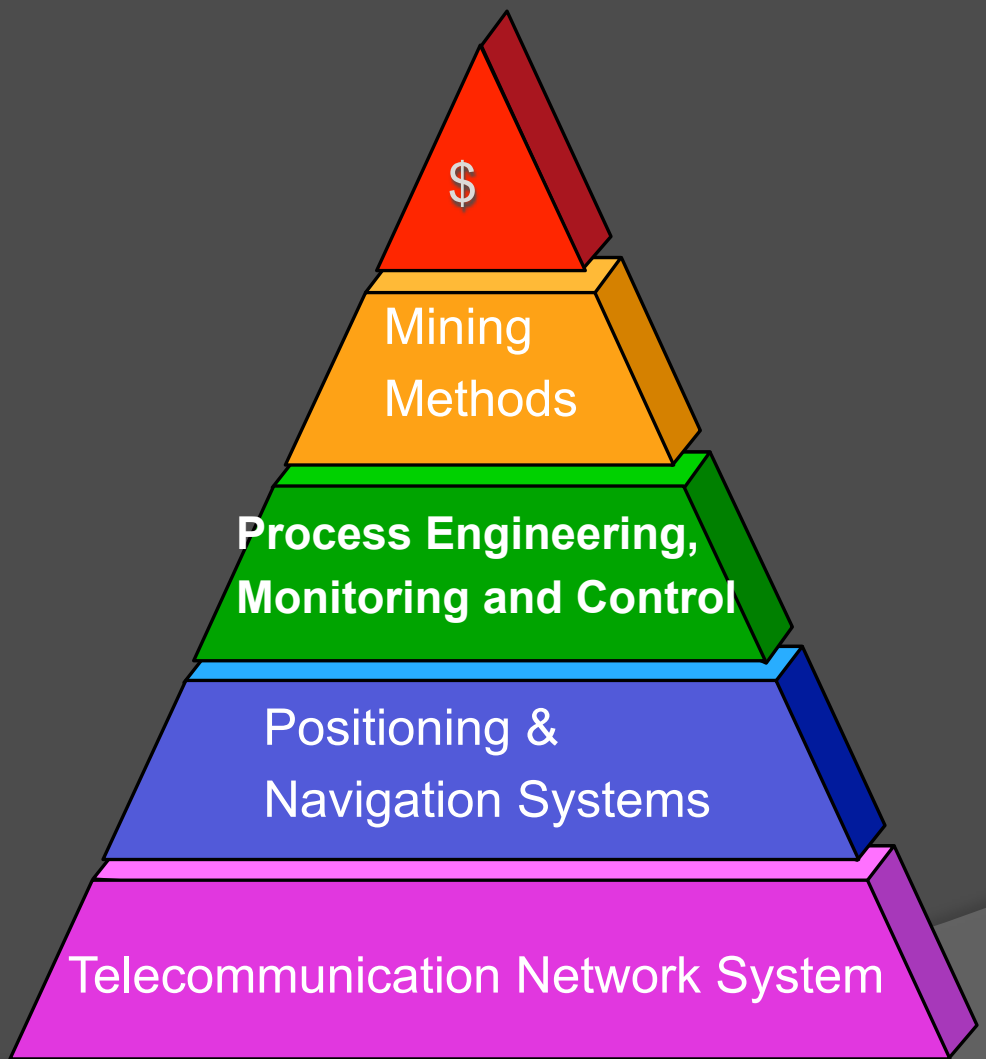

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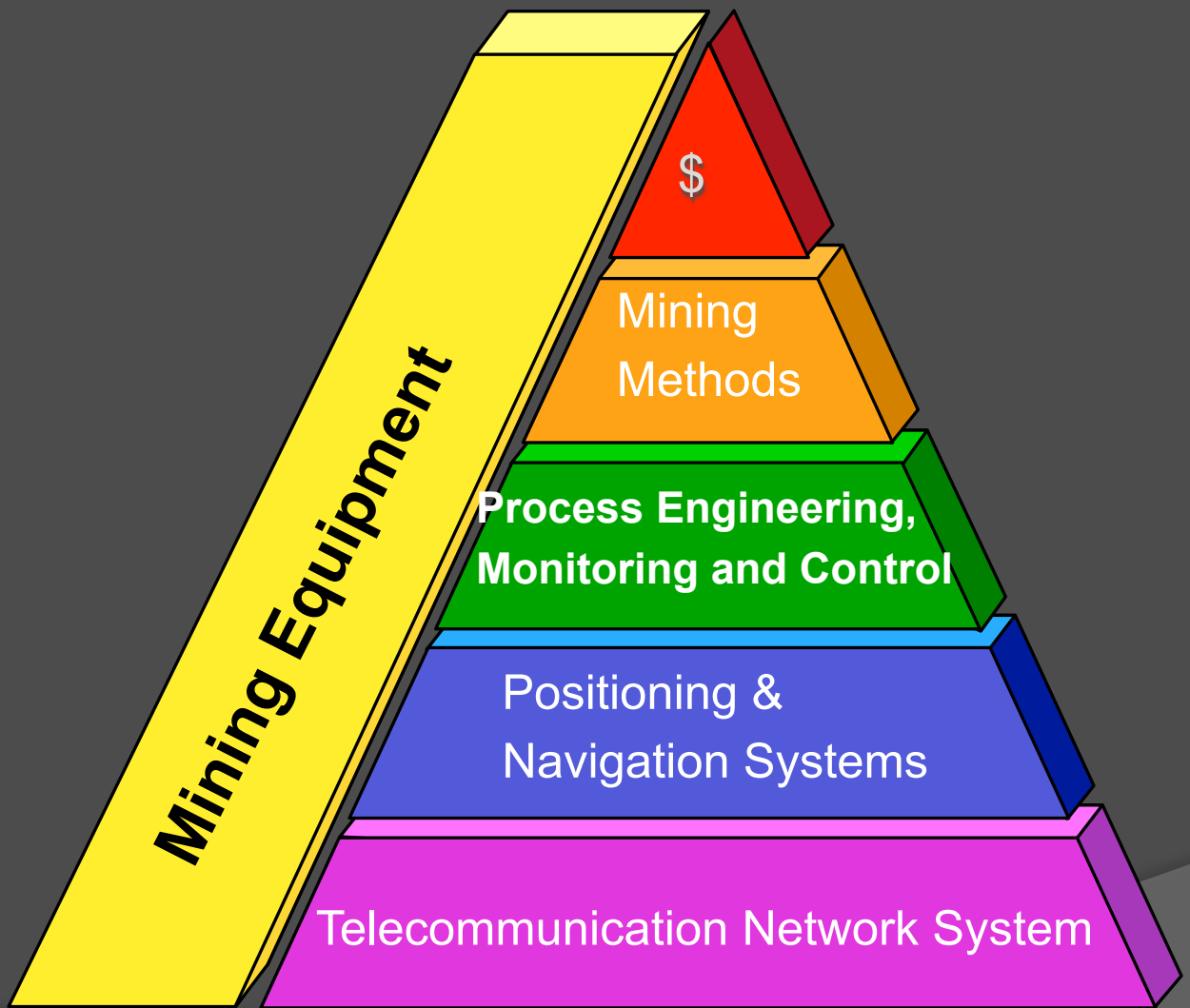

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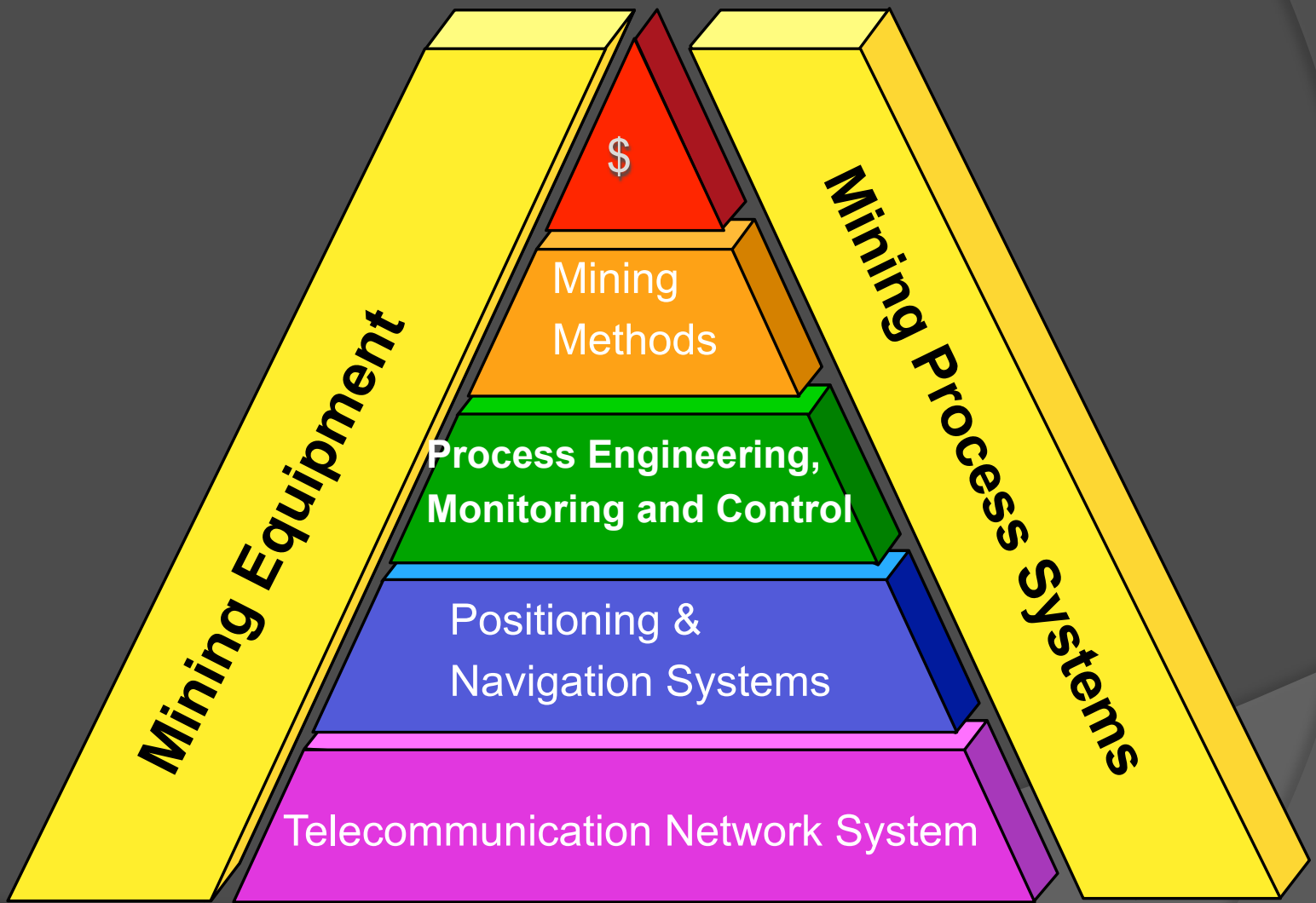

Underground Radio

- Patented High Capacity Mining Network
- Information Transfer
  - Voice
  - Data
  - Video

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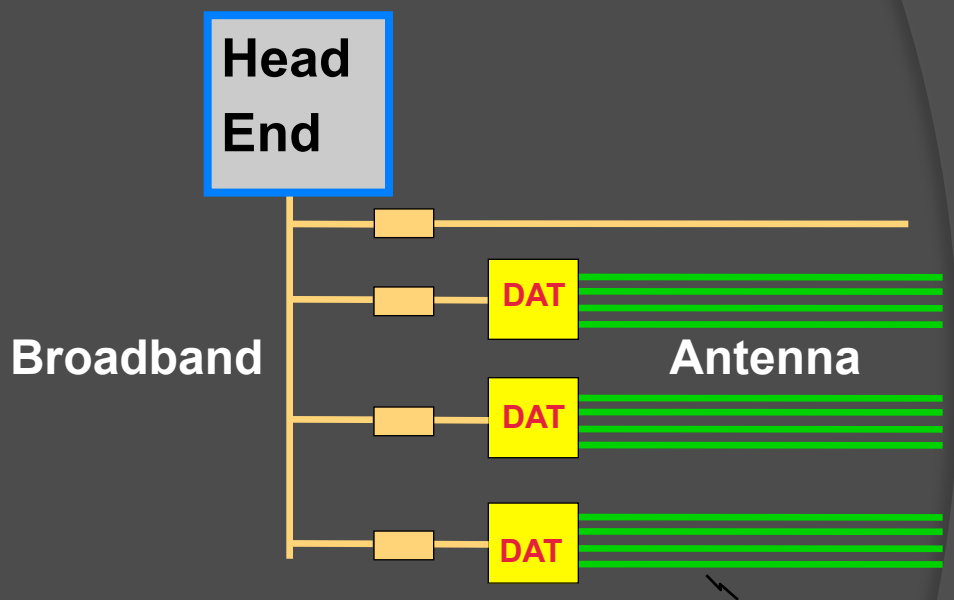

Positioning, Navigation & Communication

- Critical underground positioning technology
- Examples Include:
  - Production Drill Setup
  - Diamond Drill Setup
  - Development Jumbo Setup
  - Raise Borer Setup

Non-GPS Mapping and Surveying

Non-GPS Mapping and Surveying

HORTA - IMU

Non-GPS Mapping and Surveying

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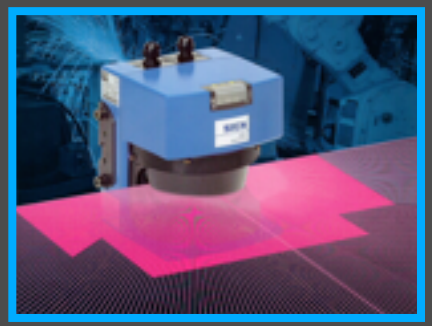
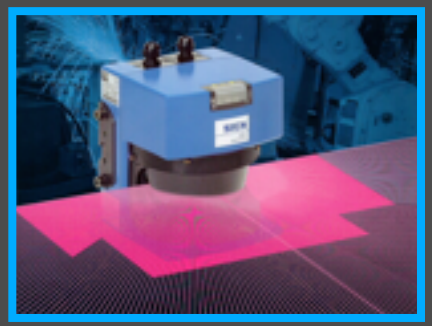


PLS-Proximity Laser Scanner

Non-GPS Mapping and Surveying

HORTA - IMU



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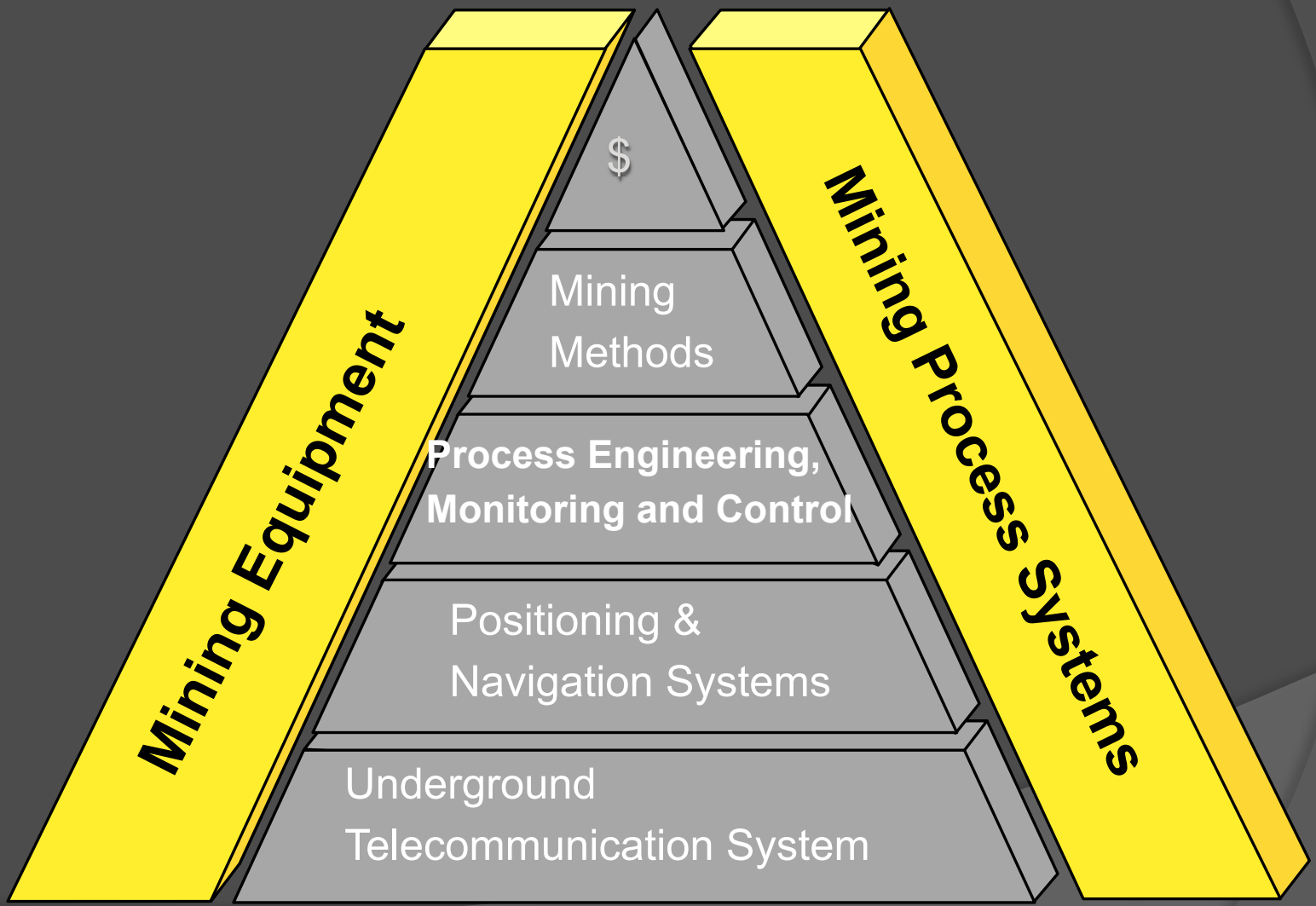
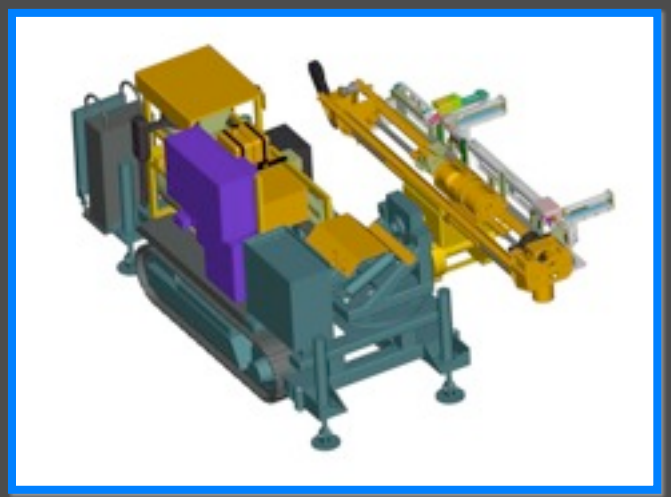
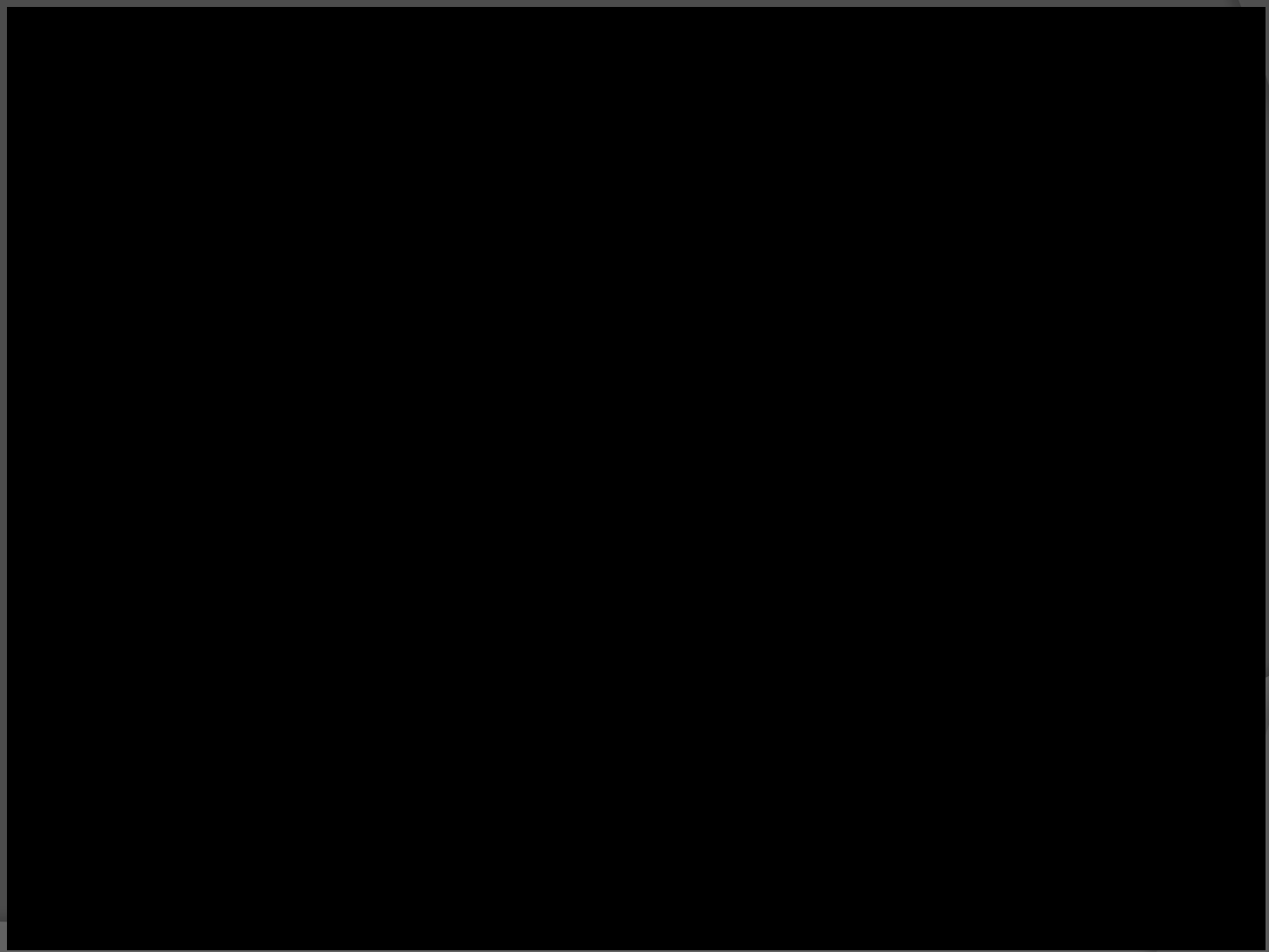


Telemining



Tele- Exploration drilling

Tele- Exploration drilling



Tele- Tunneling

Tele- Tunneling

Tele-Production Drilling

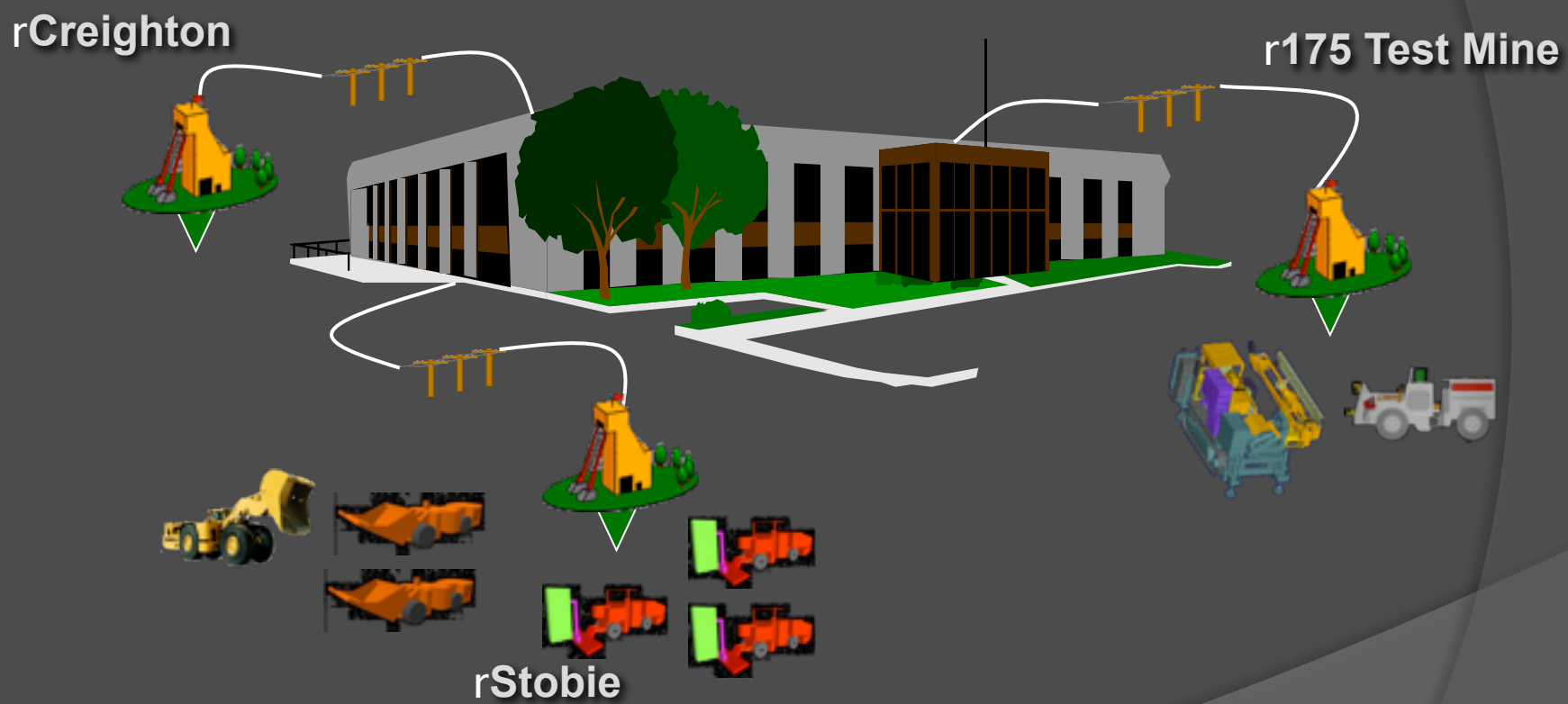


Tele-Production Drilling

Tele- Production Materials Handling

Tele- Production Materials Handling

Mine Operations Center



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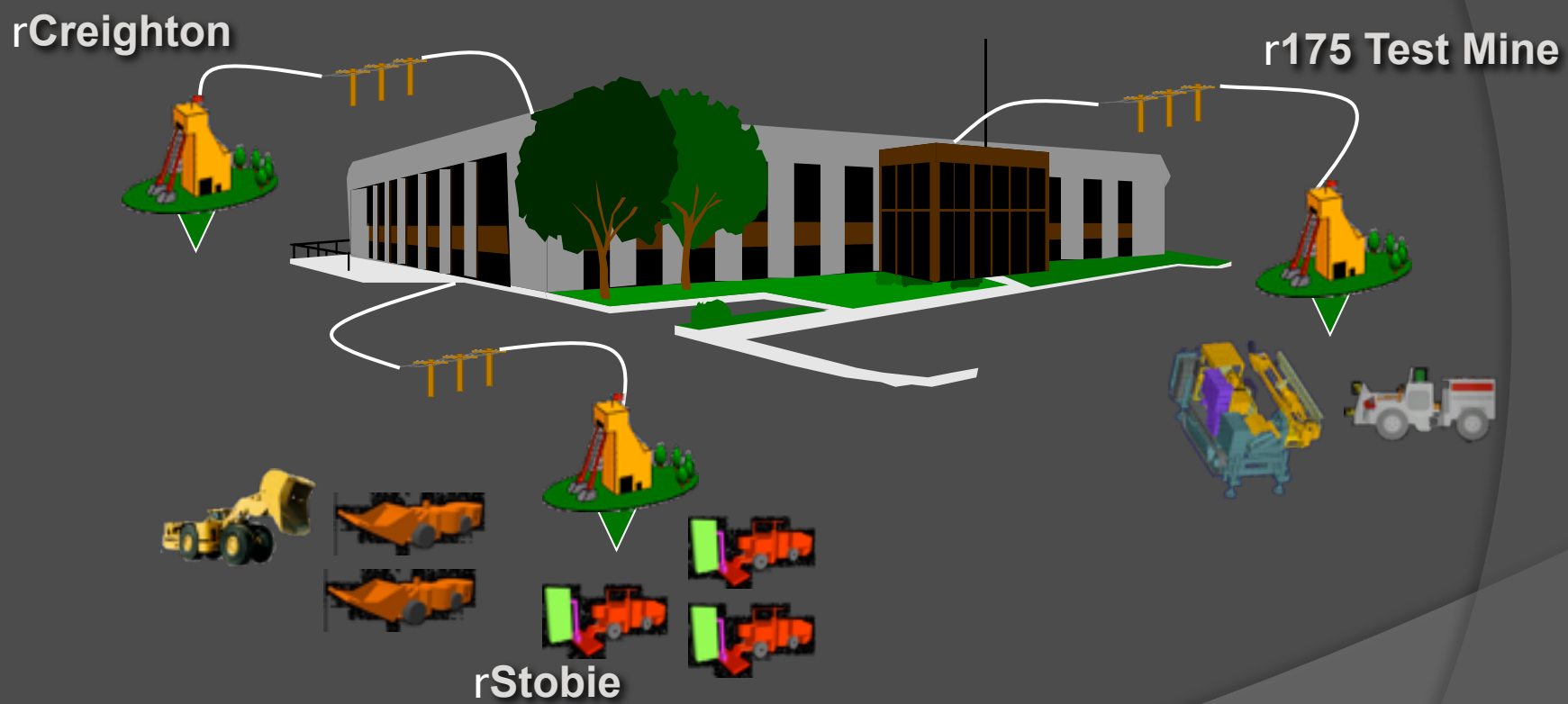
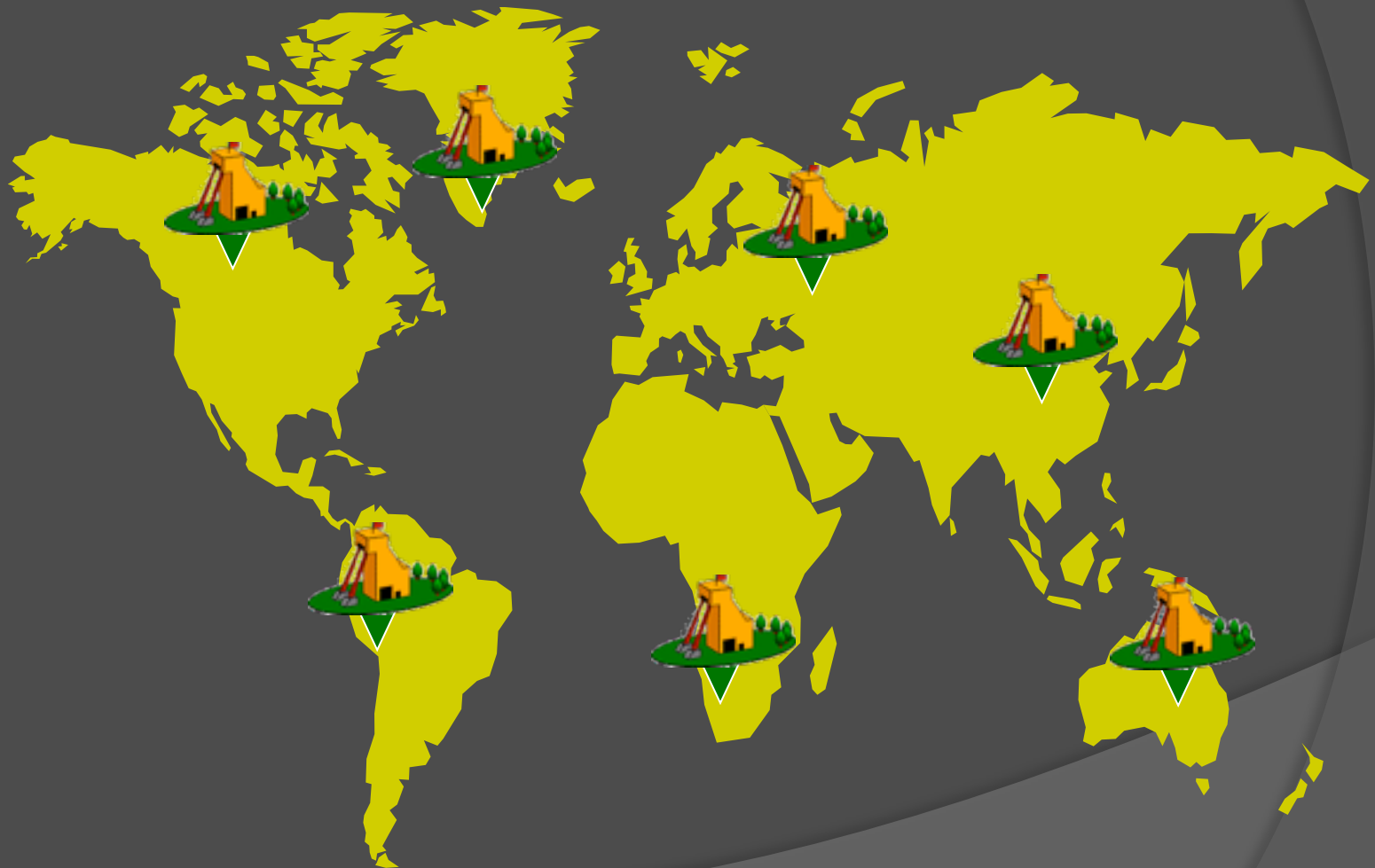


Mine Operation Centers

International Mine Contracting Business



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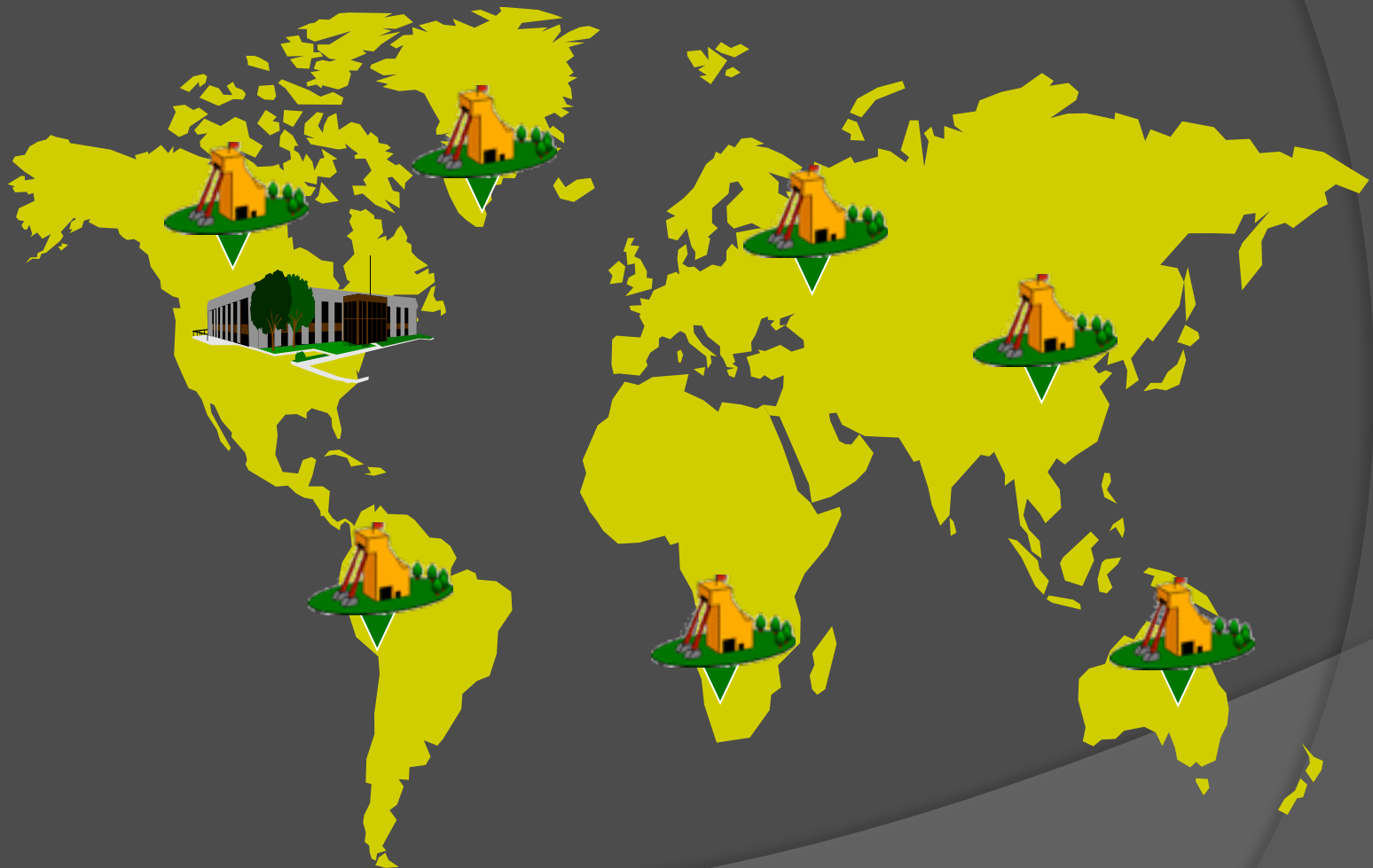

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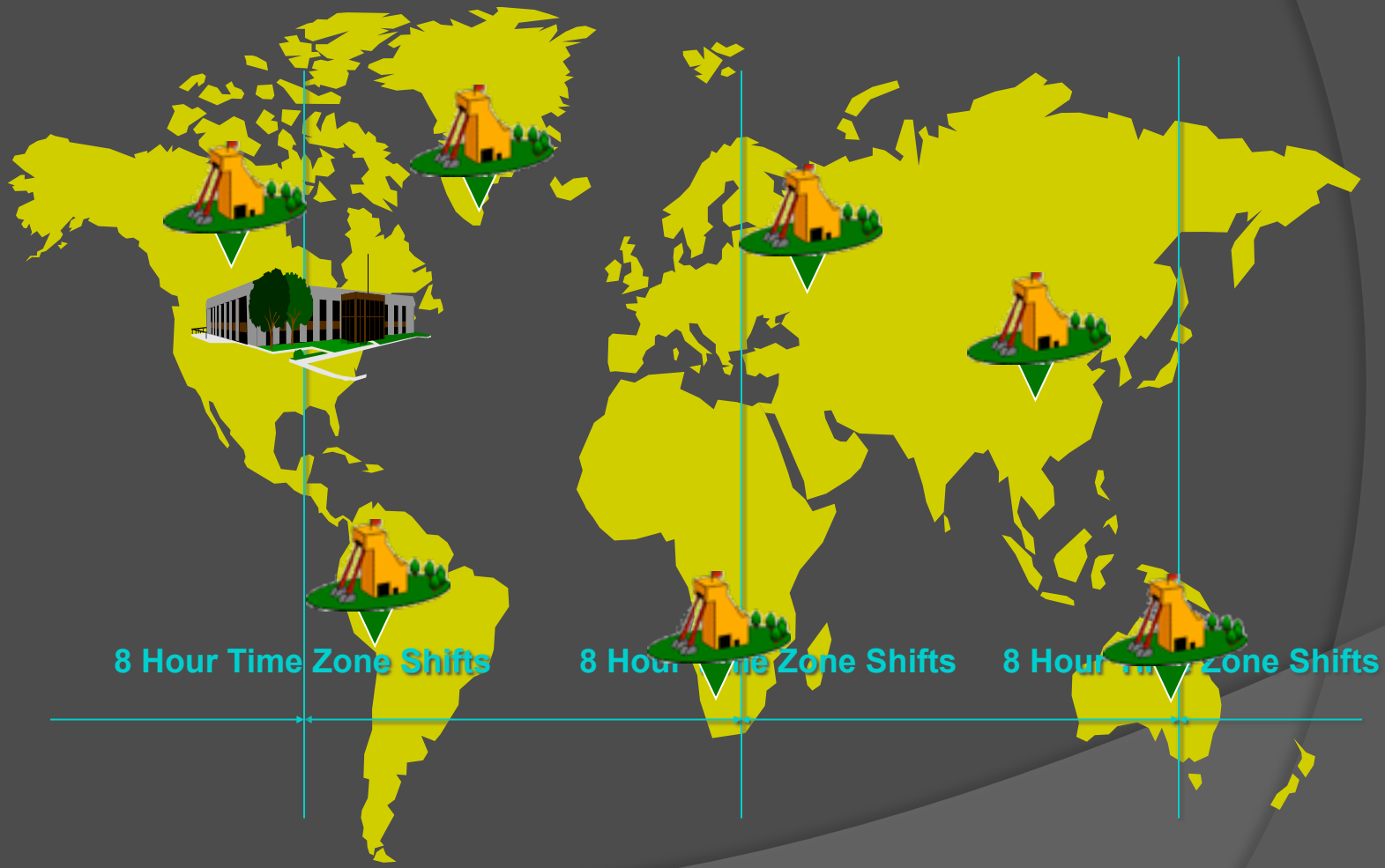

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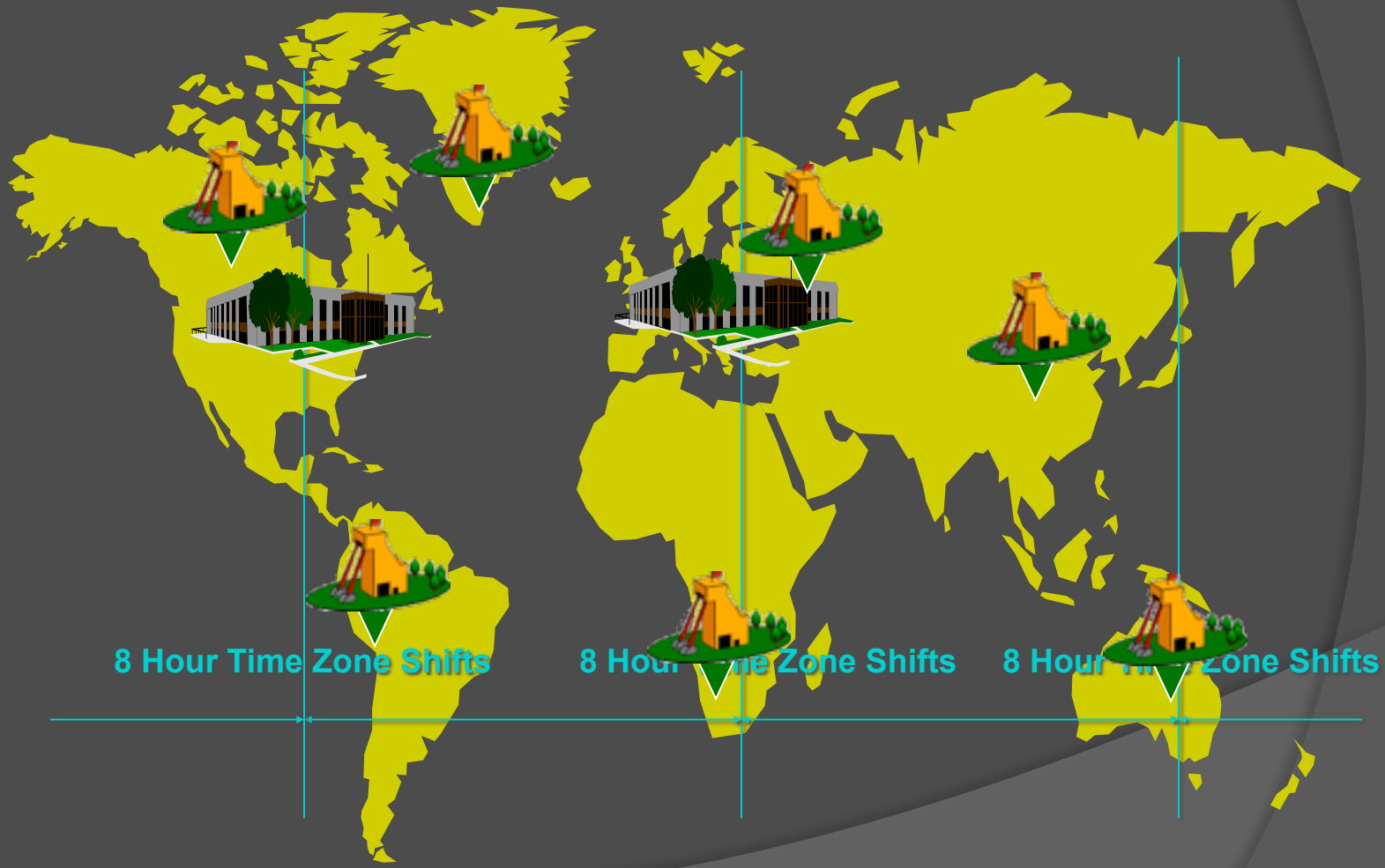

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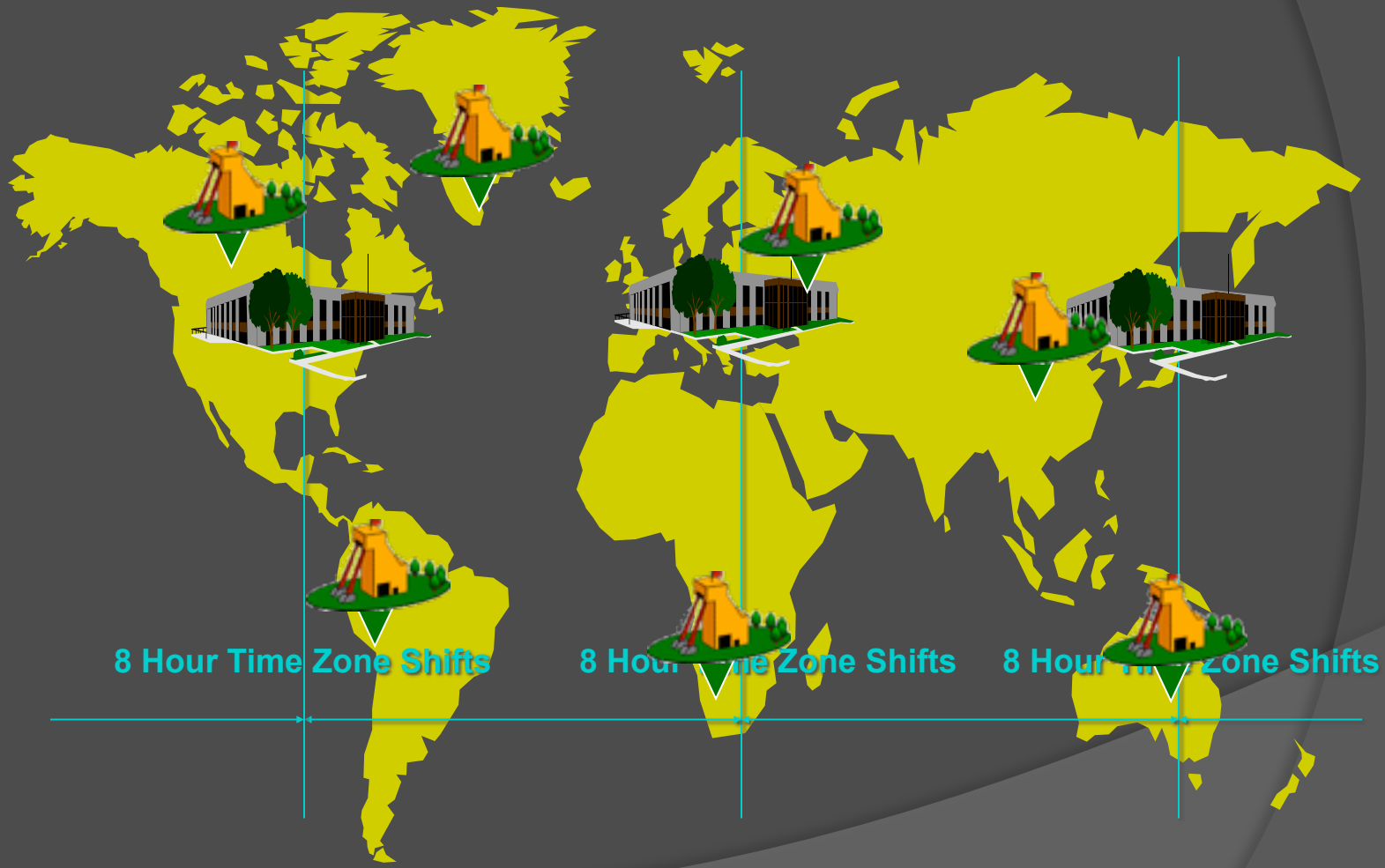

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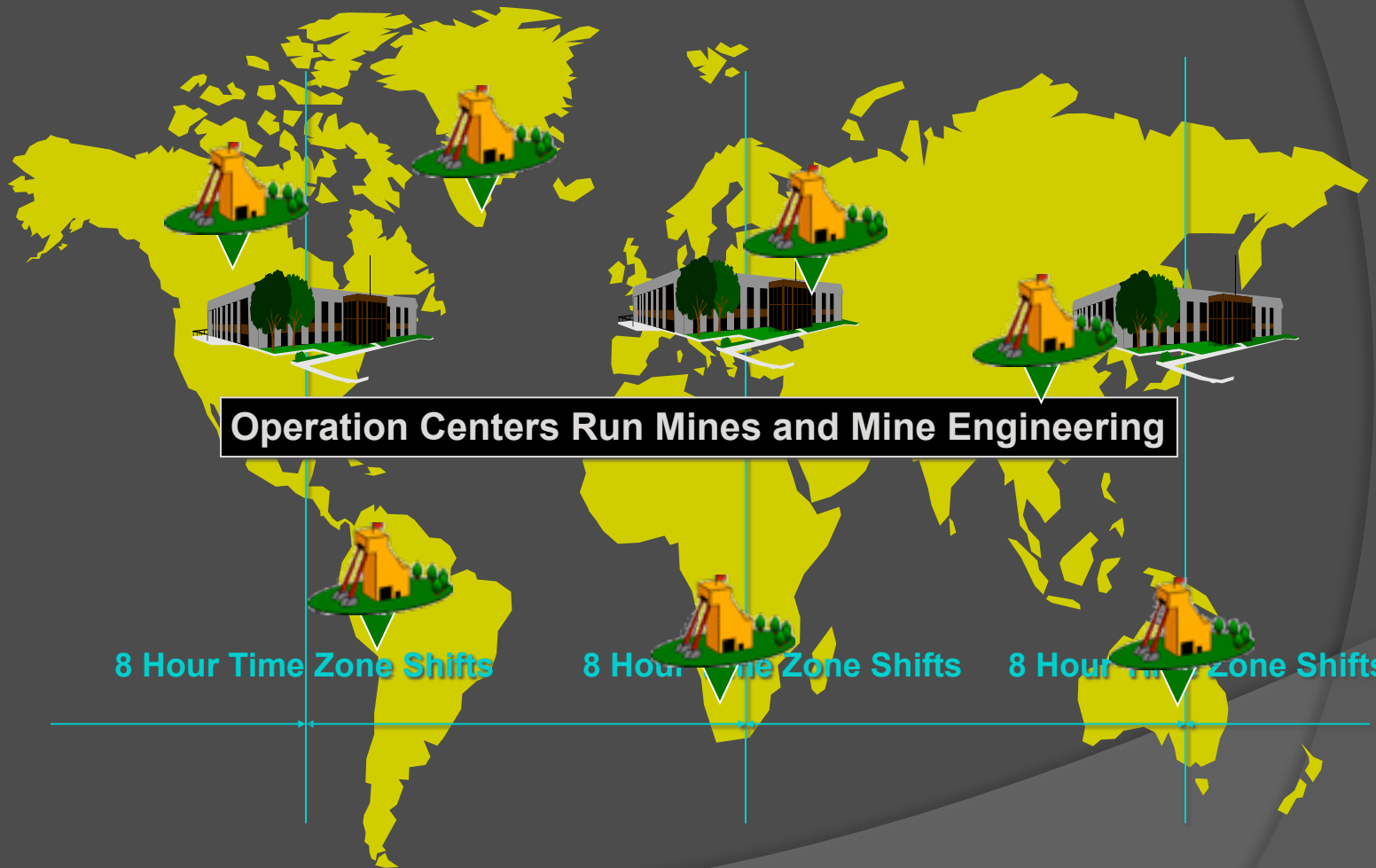

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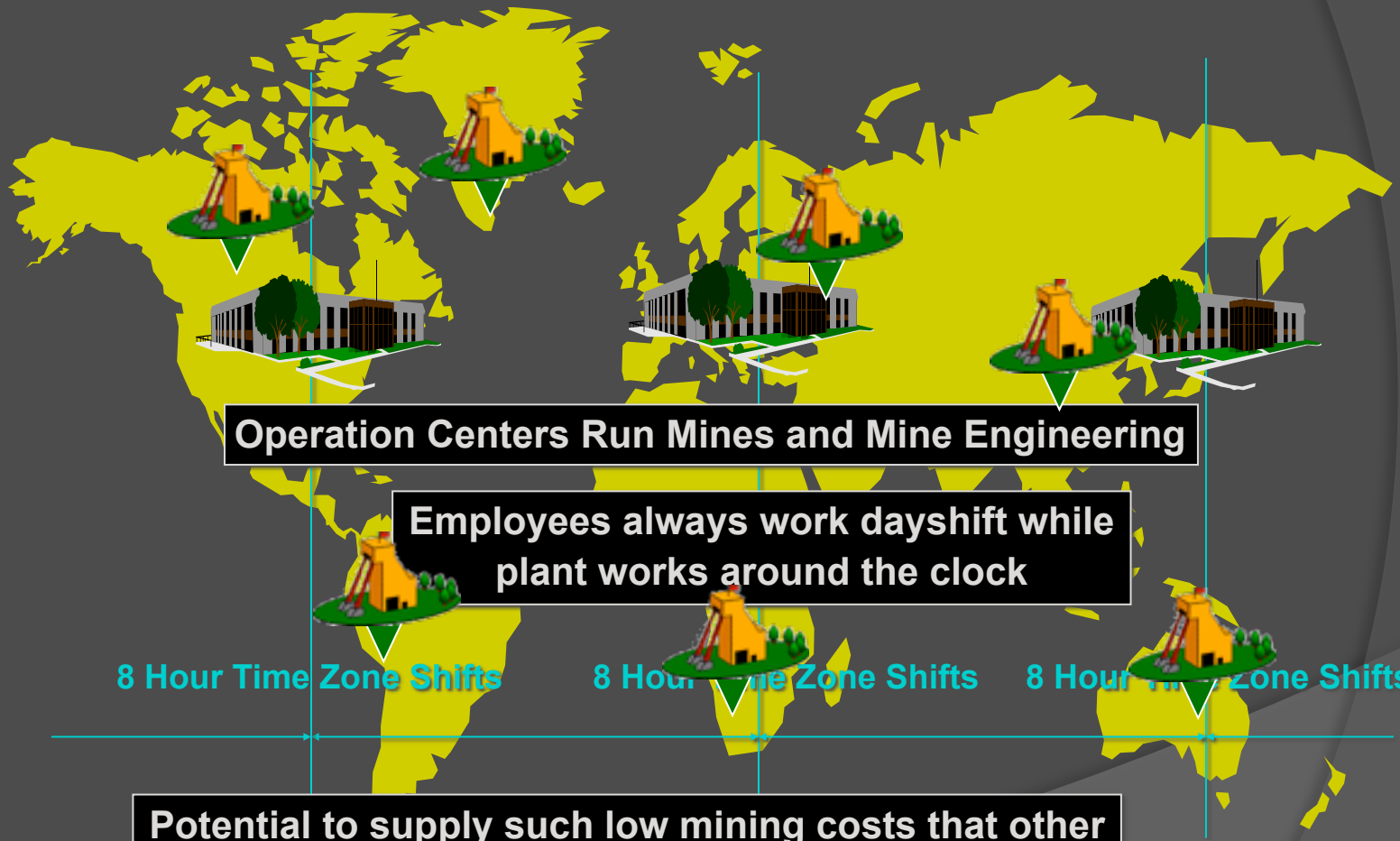

Summary

- Telemining technology is becoming the norm that will lead the international terrestrial mining community
- Lunar Mining or extraterrestrial telemining can be a reality is a fairly short time scale using existing capabilities if the market for product and transportation systems are available
- Tomorrows lunchtime talk will provide a potential scenerio

Historic and Projected Productivity Improvements

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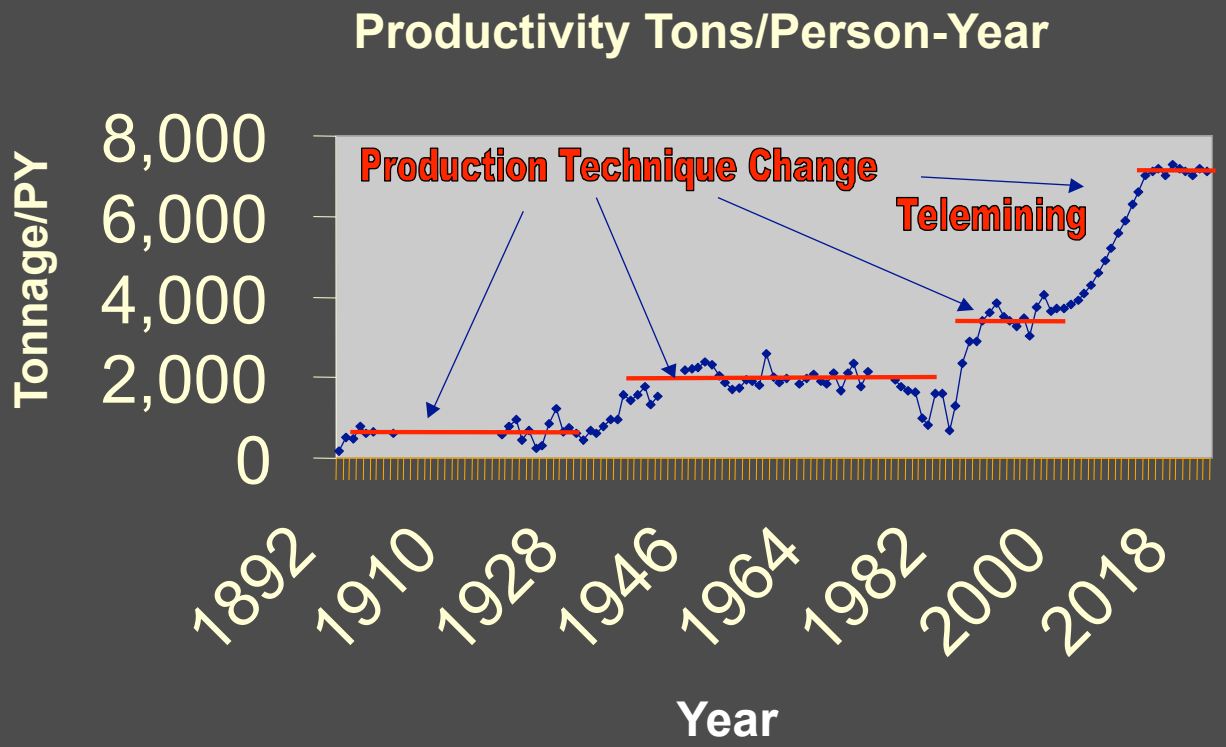

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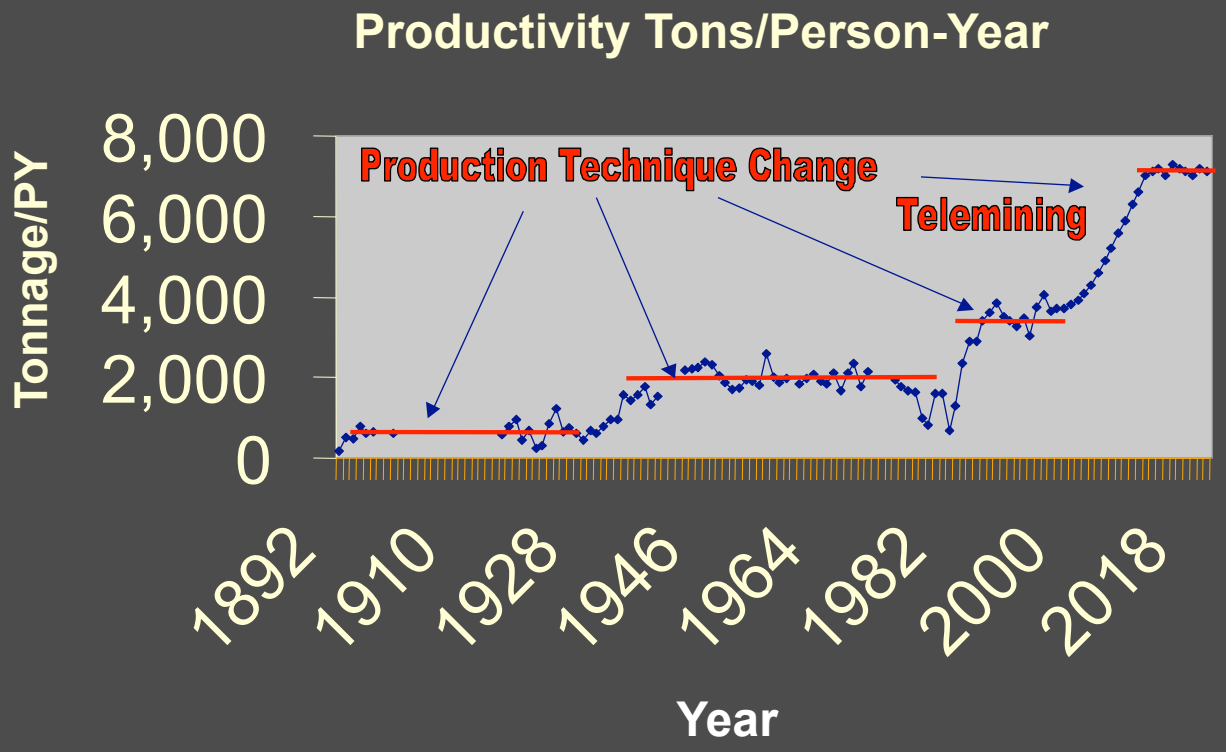

* Telemining will become our future production technique

Long Duration