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

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Baseline NASA Lunar Architecture (LAT2 - 2008)

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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)
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)
Lunar Mining leading to subsurface habitation
Either this or gravity
Mining Terms
Mining Terms

ORE BODY
RAMP
EXPLORATION DRIFT
CRUSHER
BIN
HEADERAME
MAIN SHAFT
Design to Production
Automatic Haulage Truck –
Automatic Haulage Truck –
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

Telecommunication Network System

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Key Technologies for

Positioning & Navigation Systems

Telecommunication Network System
Key Technologies for

Telecommunication Network System

Positioning & Navigation Systems

Process Engineering, Monitoring and Control

Telecommunication Network System
Key Technologies for

Telecommunication Network System
Positioning & Navigation Systems
Process Engineering, Monitoring and Control
Positioning & Navigation Systems
Telecommunication Network System

Mining Methods
Key Technologies for

- Telecommunication Network System
- Positioning & Navigation Systems
- Process Engineering, Monitoring and Control
- Mining Methods
- $
Key Technologies for

- Mining Equipment
- Telecommunication Network System
- Positioning & Navigation Systems
- Process Engineering, Monitoring and Control
- Mining Methods
- $
Key Technologies for

Mining Equipment

Mining Process Systems

$\$

Mining Methods

Process Engineering, Monitoring and Control

Positioning & Navigation Systems

Telecommunication Network System

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Underground Radio

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

- Patented High Capacity Mining Network

- Information Transfer
  - Voice
  - Data
  - Video
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
Non-GPS Mapping and Surveying

HORTA - IMU

PLS-Proximity Laser Scanner
Non-GPS Mapping and Surveying

HORTA - IMU

PLS-Proximity Laser Scanner
Key Technologies for
Key Technologies for

- Mining Equipment
- Mining Process Systems

- Underground Telecommunication System
- Positioning & Navigation Systems
- Process Engineering, Monitoring and Control
- Mining Methods
- $
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

rCreighton

rStobie

r175 Test Mine

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Mine Operation Centers
International Mine Contracting Business

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8 Hour Time Zone Shifts

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Mine Operation Centers
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Operation Centers Run Mines and Mine Engineering

8 Hour Time Zone Shifts
Mine Operation Centers
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Operation Centers Run Mines and Mine Engineering

Employees always work dayshift while plant works around the clock

8 Hour Time Zone Shifts 8 Hour Time Zone Shifts 8 Hour Time Zone Shifts
Mine Operation Centers
International Mine Contracting Business

Operation Centers Run Mines and Mine Engineering

Employees always work dayshift while plant works around the clock

Potential to supply such low mining costs that other companies mines could be operated for them
Summary

- Telemining technology is becoming the norm that will lead the international terrestrial mining community.
- Lunar Mining or extraterrestrial telemining can be a reality in a fairly short time scale using existing capabilities if the market for product and transportation systems are available.
- Tomorrow’s lunchtime talk will provide a potential scenario.
Historic and Projected Productivity Improvements
Historic and Projected Productivity Improvements

Productivity Tons/Person-Year

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<th>Tonnage/PY</th>
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Production Technique Change
Telemining

Saturday, November 20, 2010
Historic and Projected Productivity Improvements

* Telemining will become our future production technique
Long Duration