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Penguin Automated Systems Inc.

The Mine of the Future
Current Mine Automation Trends

Dr. G. Baiden
Canadian Research Chair – Robotics and Mine Automation
Laurentian University
Chairman and CTO
Penguin Automated Systems Inc.

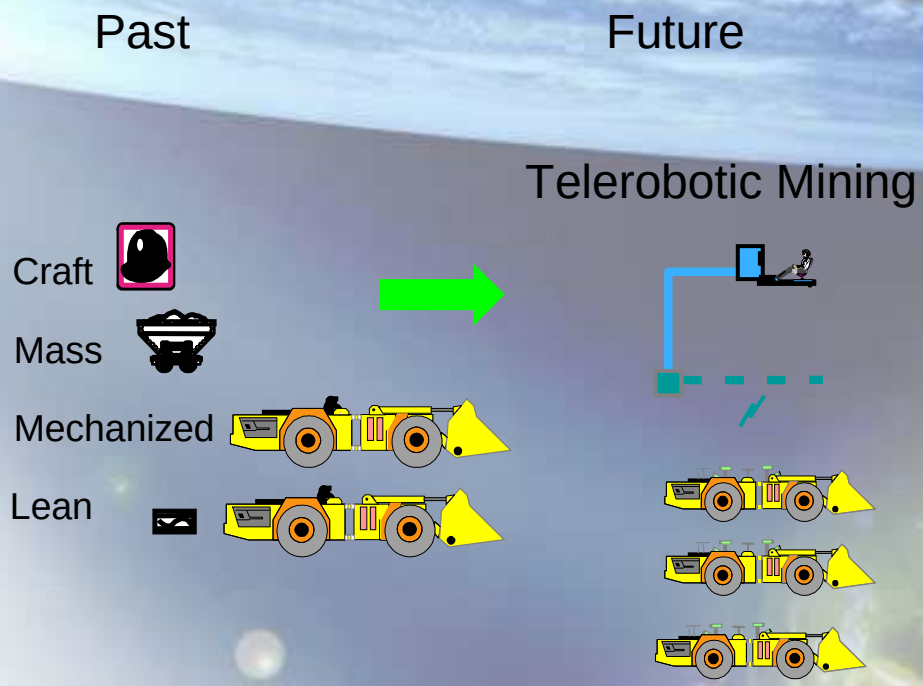
LaurentianUniversity
UniversitéLaurentienne

Future Possibilities to be considered

- Robotics and Advanced Manufacturing Techniques applied to current mining
  - Mine large low grade deep deposits
    - Perfect Safety, Minimize Costs and Maximize Revenues
  - Mine Large Scale Underwater Deposits
  - Begin to look at Space
- Demand for minerals and metals continues to grow
  - 2% growth means the current production on the earth must double every 38 years to keep up with demand!! Or prices will rise.

Mining and Processing Plant Integration

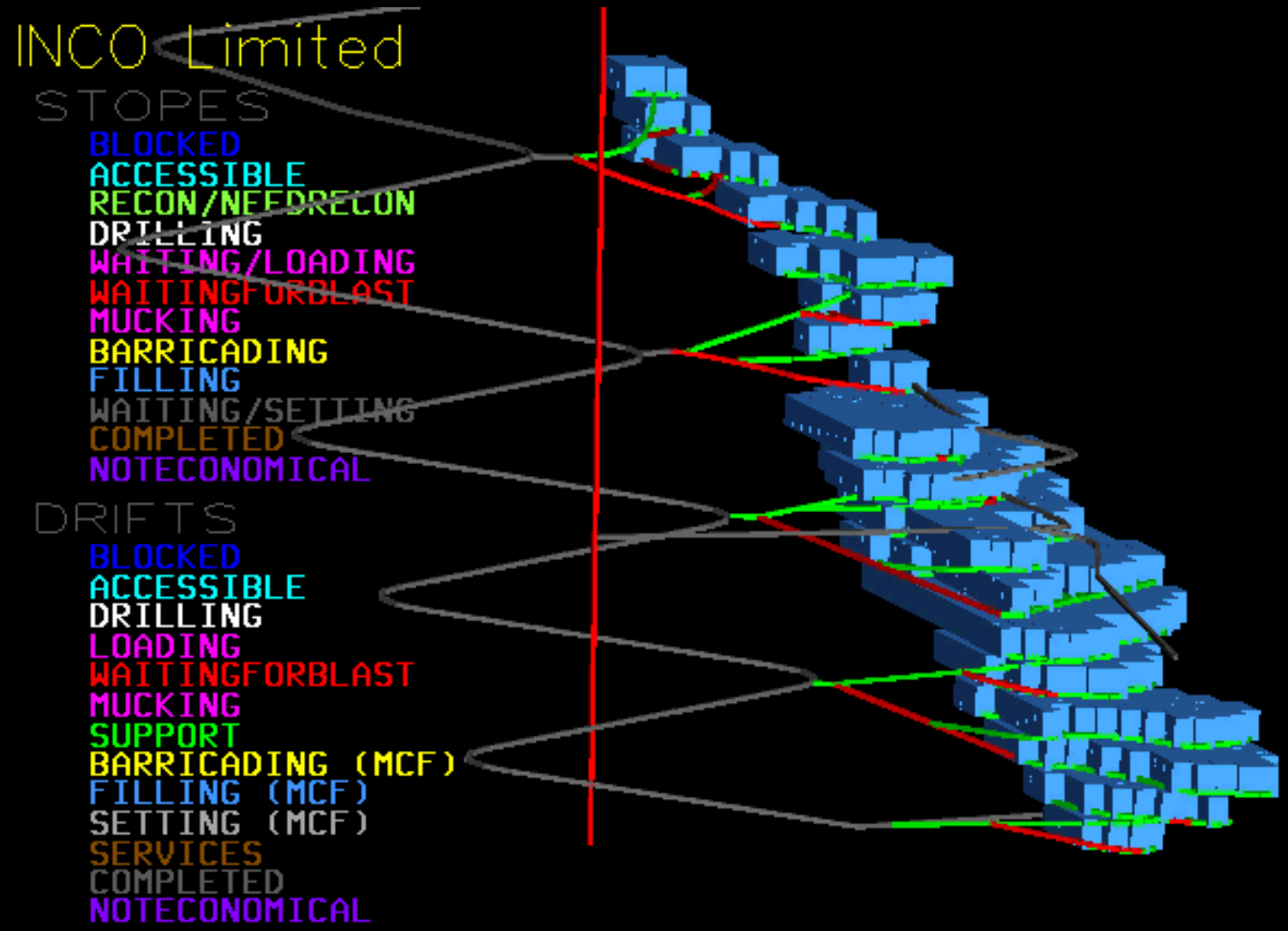
- Mining Unit Operations
  - U/G and Open Pit
  - Understand Unit Process timing
- Computer integrated Manufacturing Techniques applied to mining (Toyota Production System)
- Compared Manual Techniques to Teleremote



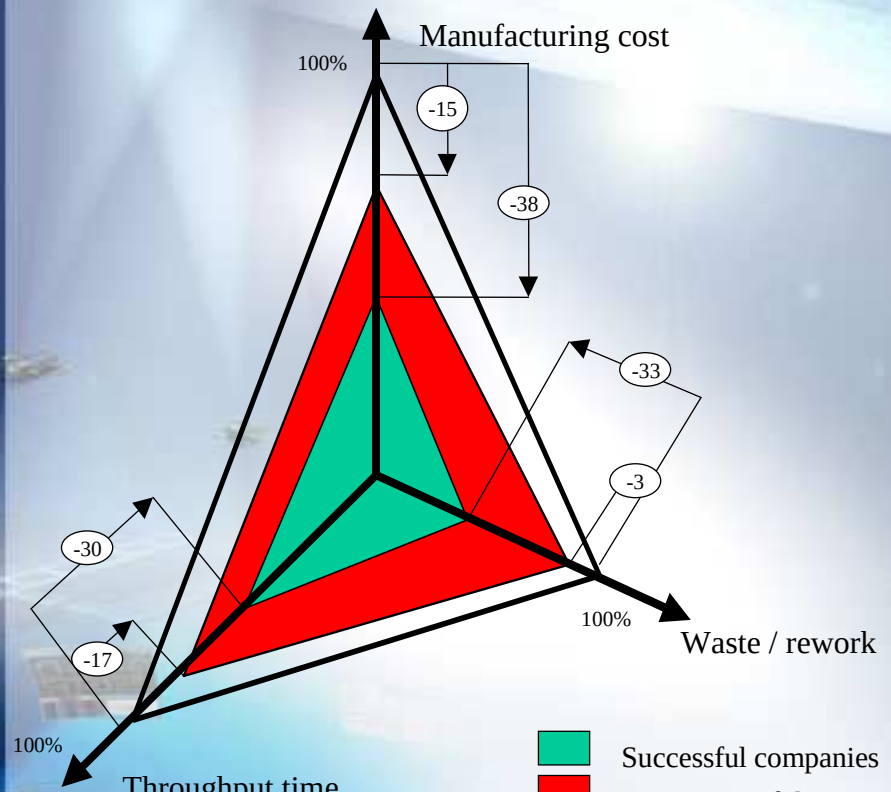
The six Epochs of Production Technology Changes

	English System	American System	Tayloristic System	Dynamic	Numerically Controlled	Computer Integrated Manufacturing
Number of Machines	3	50	150	150	50	30
Minimum Scale (people)	40	150	300	300	100	30
Staff/Line Ratio	0:40	20:130	60:240	100:200	50:50	20:10
Productivity Increase	4:1	3:1	3:1	3:2	3:1	3:1
Rework fraction	0.8	0.5	0.25	0.08	0.02	0.005
Number of Products	Large	3	10	15	100	Large
Engineering Ethos	Mechanical	Manufacturing	Industrial	Quality	Systems	Knowledge
Process Focus	Accuracy	Repeatability	Reproducibility	Stability	Adaptability	Versatility
Work Ethos	Perfection	Satisfice	Reproduce	Monitor	Control	Develop
Requied Skills	Mechanical Craft	Repetitive	Repetitive	Diagnostic	Experimental	Learning, Abstracting
Control of Work	Inspection of work	Tight supervision	Supervision	Loose supervision	No work supervision	No work supervision

Mine Simulators
developed to investigate the potential

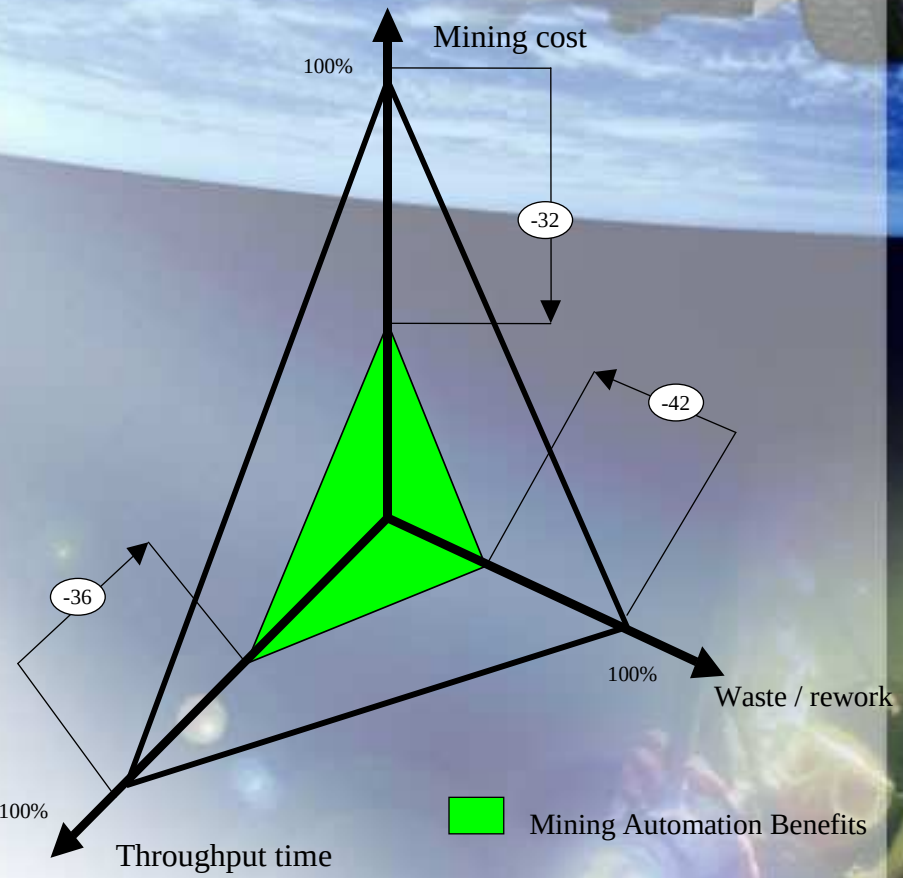


What is possible with Telerobotic Operation of Mobile Mining Machines?



Successful companies

Less successful companies



Mining Automation Benefits

Manufacturing Automation Benefits, after Rommel

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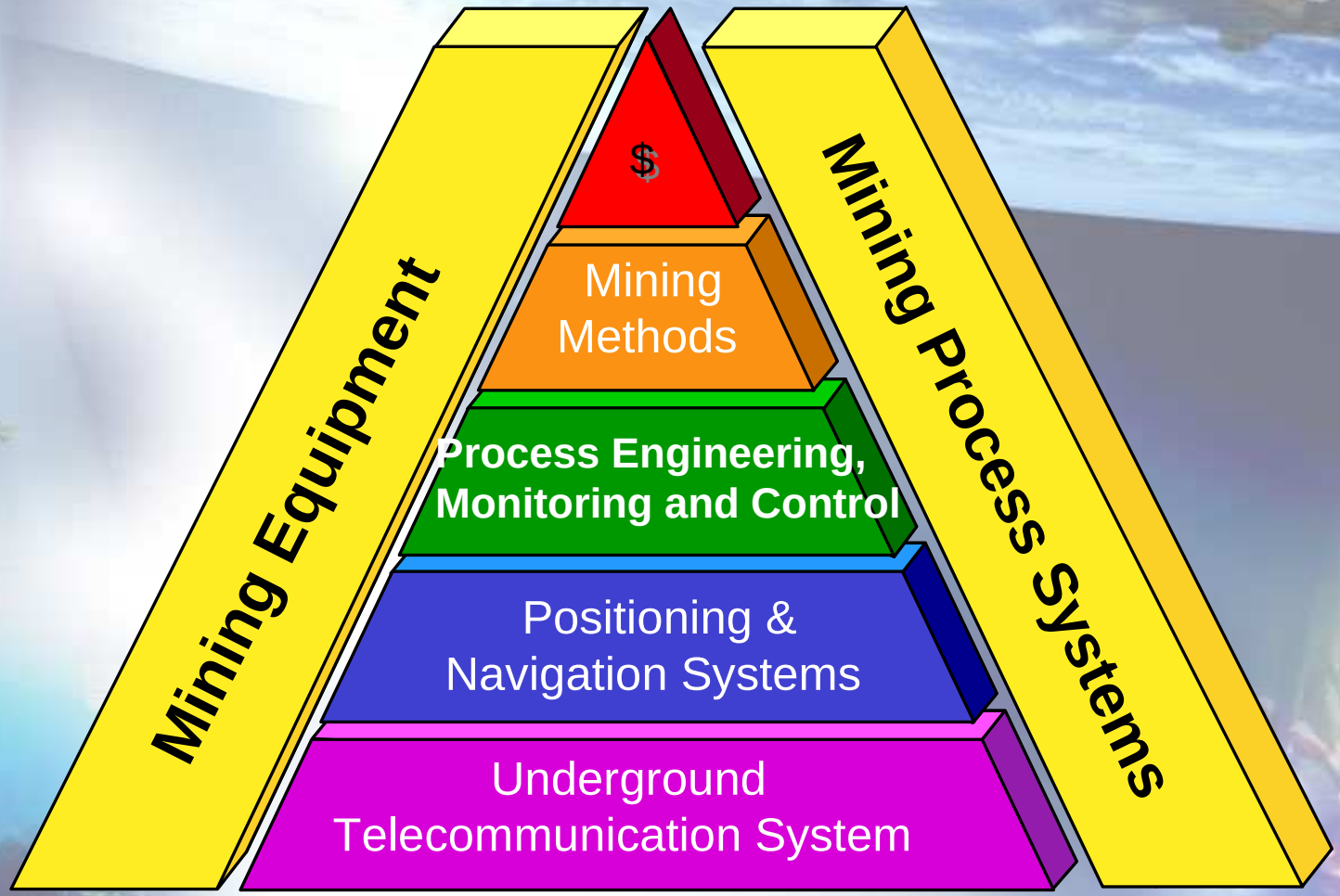
CURRENT MINING TRENDS

Global Mining
with the use of
Operation Centres

Telerobotic Mining

Key Ingredients

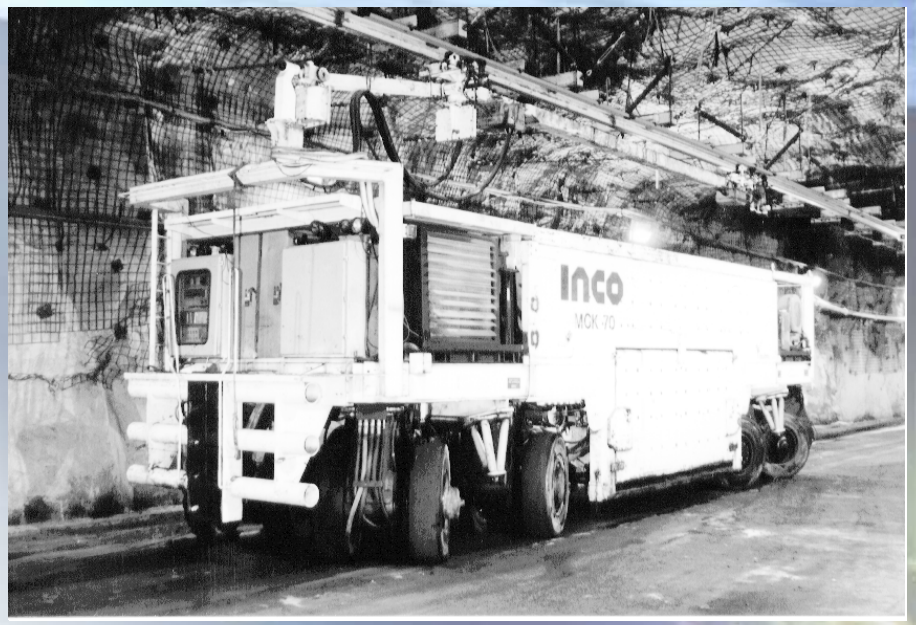


Telecommunications Breakthrough was required for Teleoperation

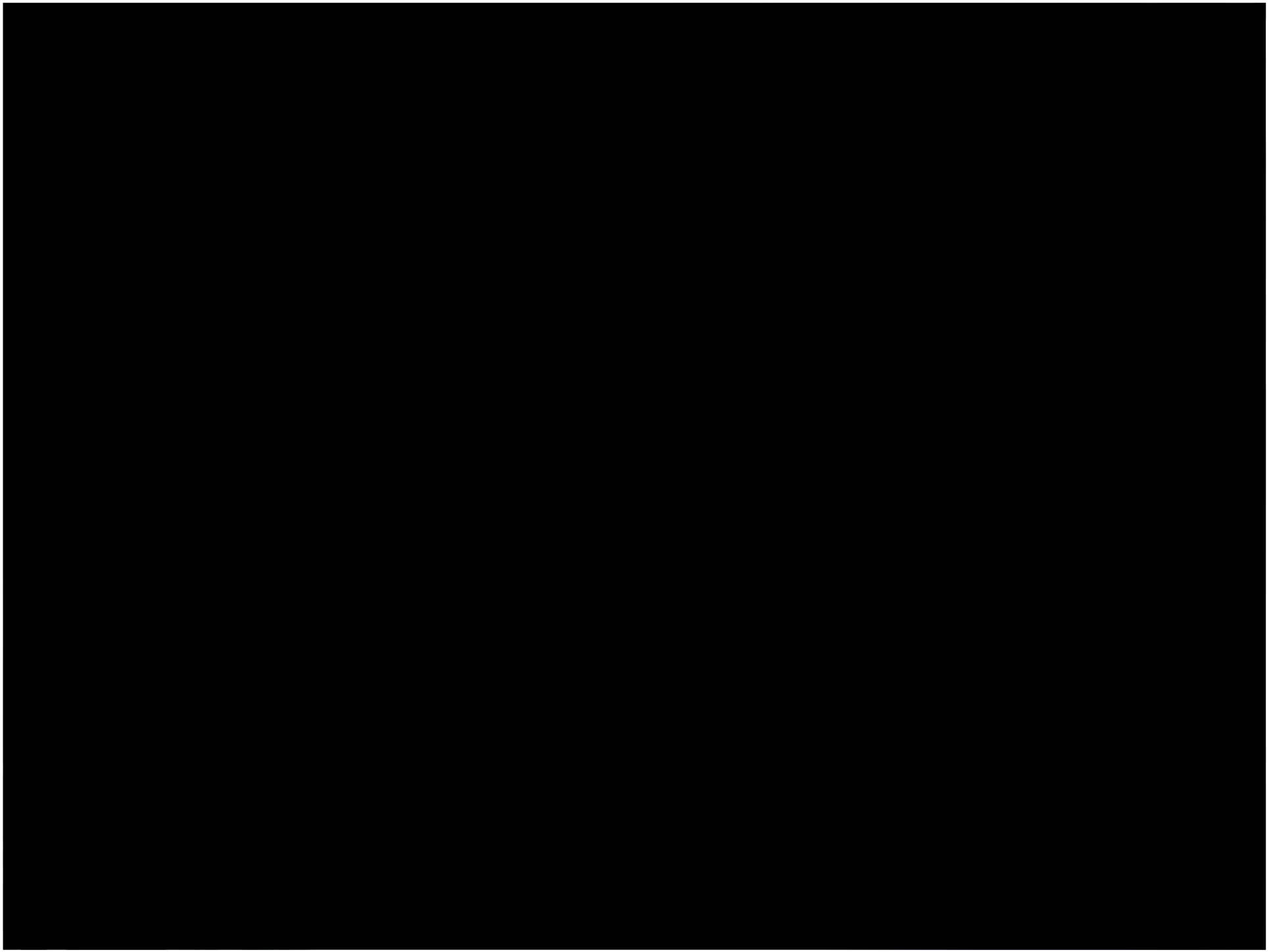
System capability 500 mb/s with near zero latency underground

Automatic Haulage Truck

- 70 ton Truck
- Electric/Hydraulic
- 25% grade capable
- Automatic Steering and Guidance
- Worked in Production for 2 years
- Moved 2 million tons
- Uptime 95%




MINING AUTOMATION PROGRAM
PROGRAMME d' AUTOMATISATION des MINES



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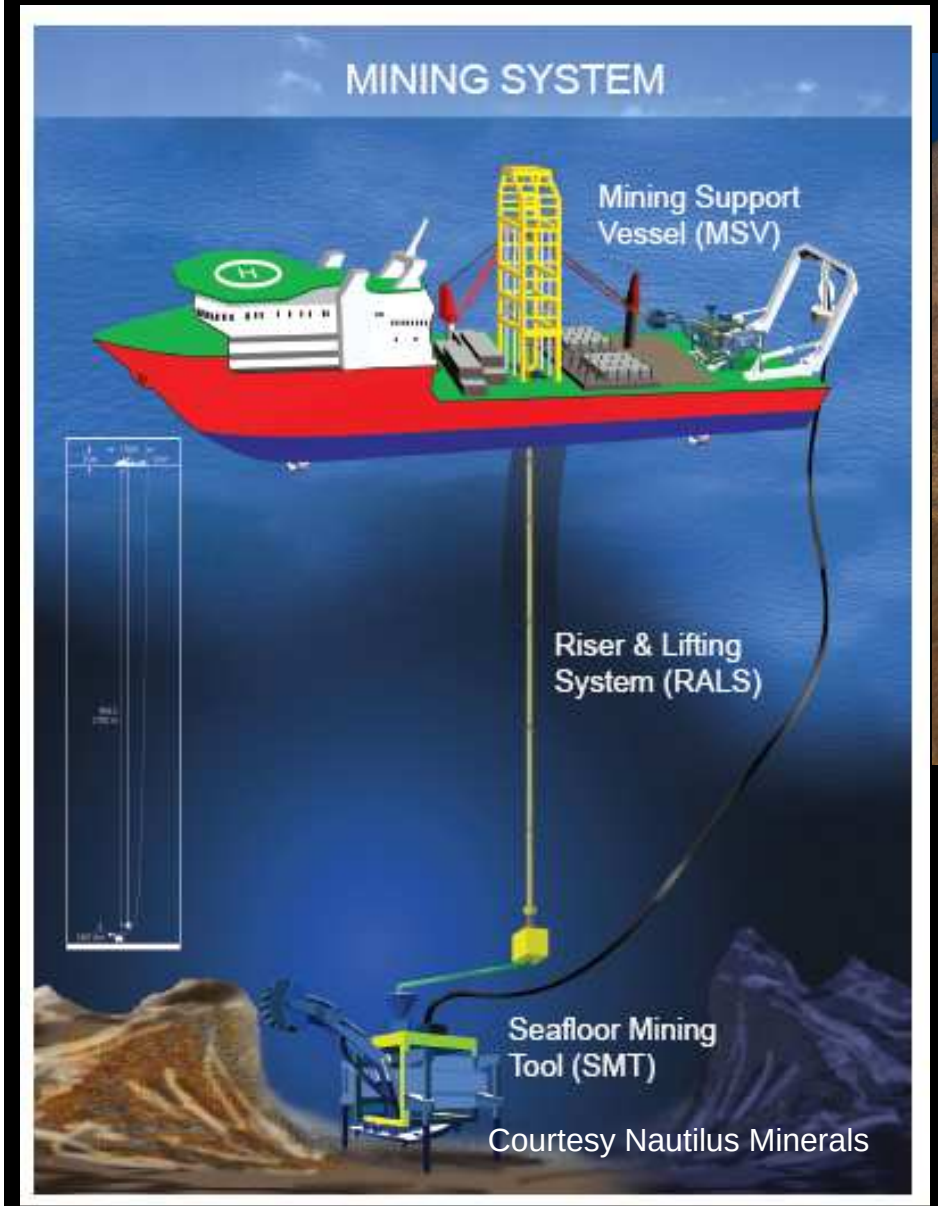
UNDERWATER MINING

Mining system to be deployed by Nautilus Minerals



Courtesy Nautilus Minerals

Courtesy Nautilus Minerals and their technical alliance partner, Soil Machine Dynamics

Mining to start in Q4 2010 subject to timely permitting

Courtesy Steve Scott

District	Hokuroku, Japan	Noranda, Canada	Solwara 1 Golder Associates NI43-101, 2008. Inferred + indicated (4% Cu cutoff) is 2,170,000 t drilled.
Mines	12	20	
Ave Mt	12	10	
Wt %			
Copper	1.6	2.1	**7.2**
Zinc	3.0	1.4	0.6
Lead	0.8	~0	-
g/t			
Silver	93	21	31
Gold	0.6	4.1	**6.2**

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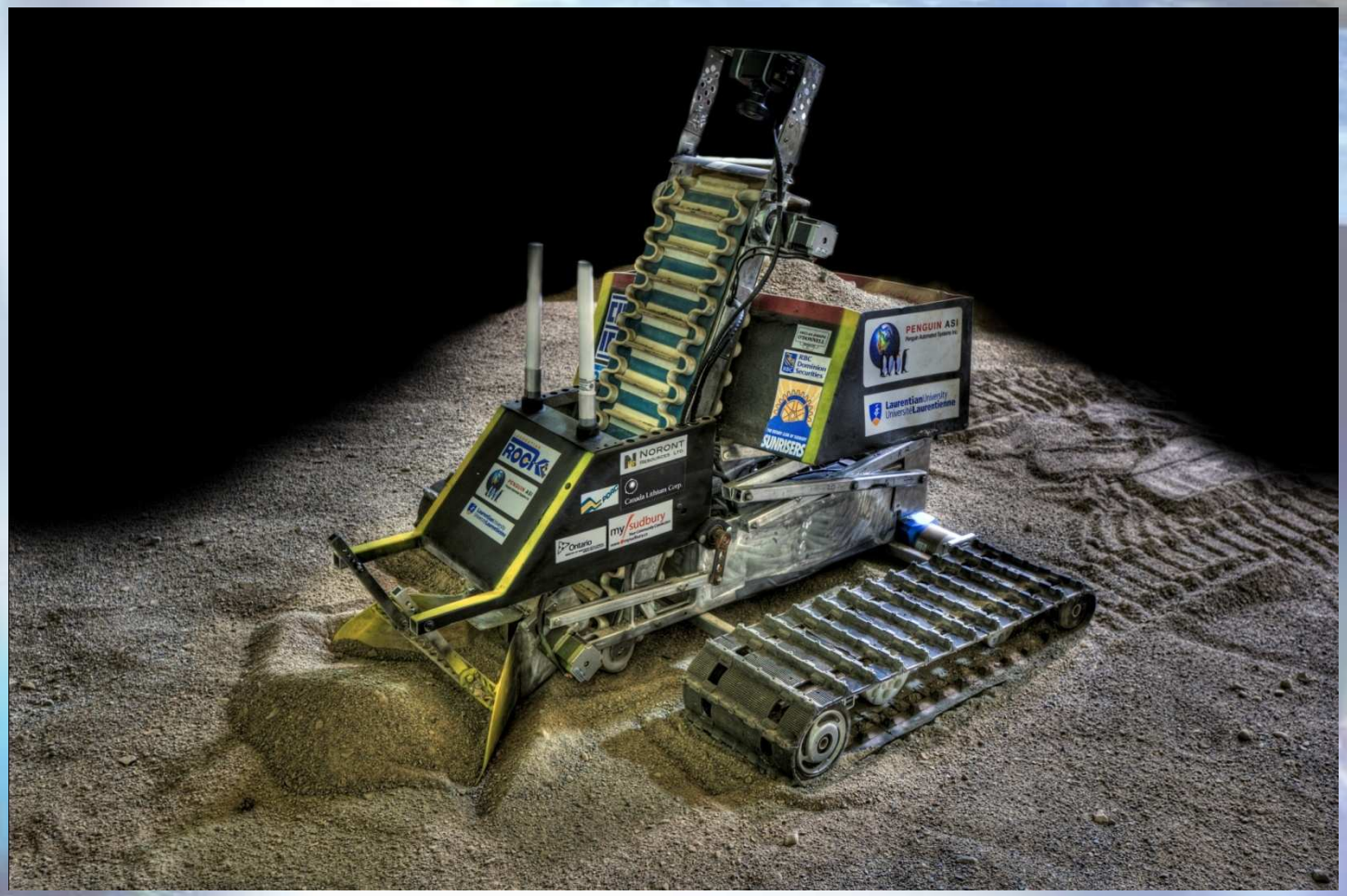
SPACE MINING

Control Systems

NASA Rokbot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BREAKTHROUGHS

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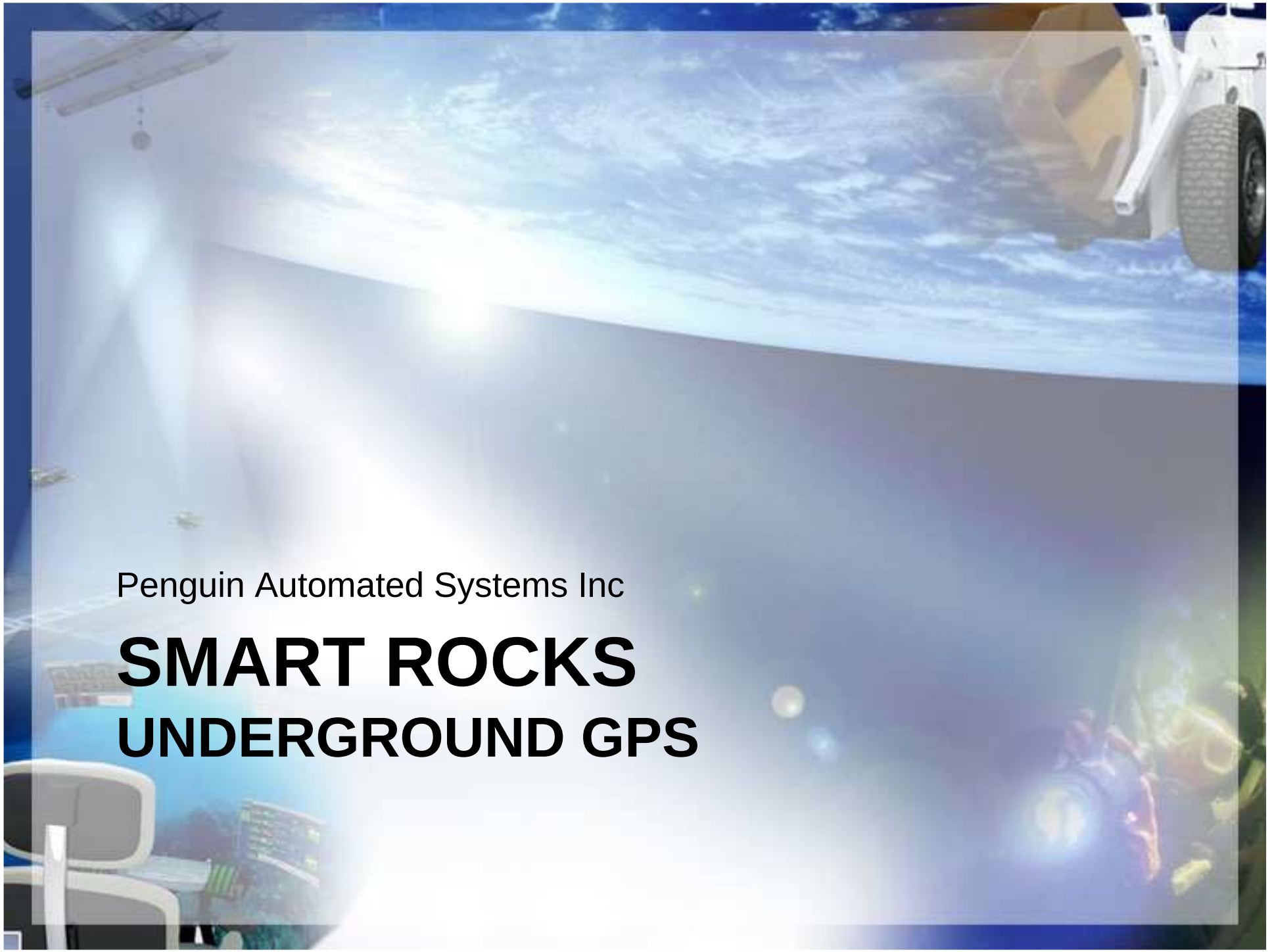
NON GPS ROBOTIC MAPPING

Non GPS Mapping System

Mine Survey using Penguin System



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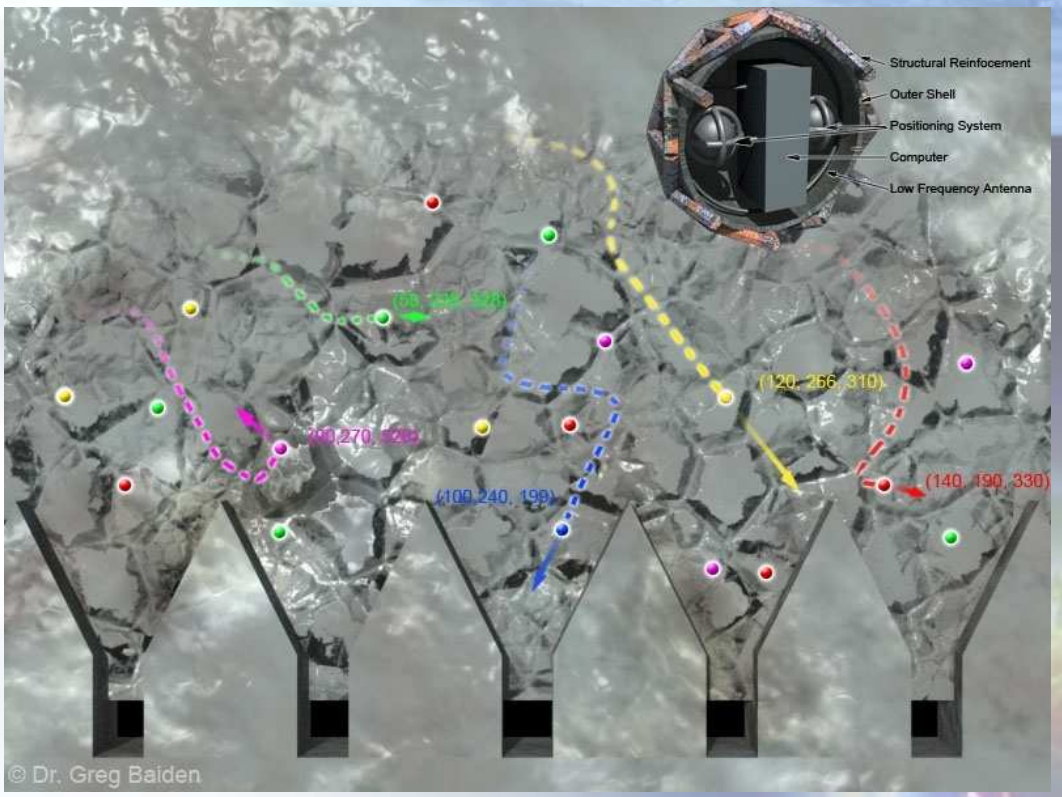
SMART ROCKS
UNDERGROUND GPS

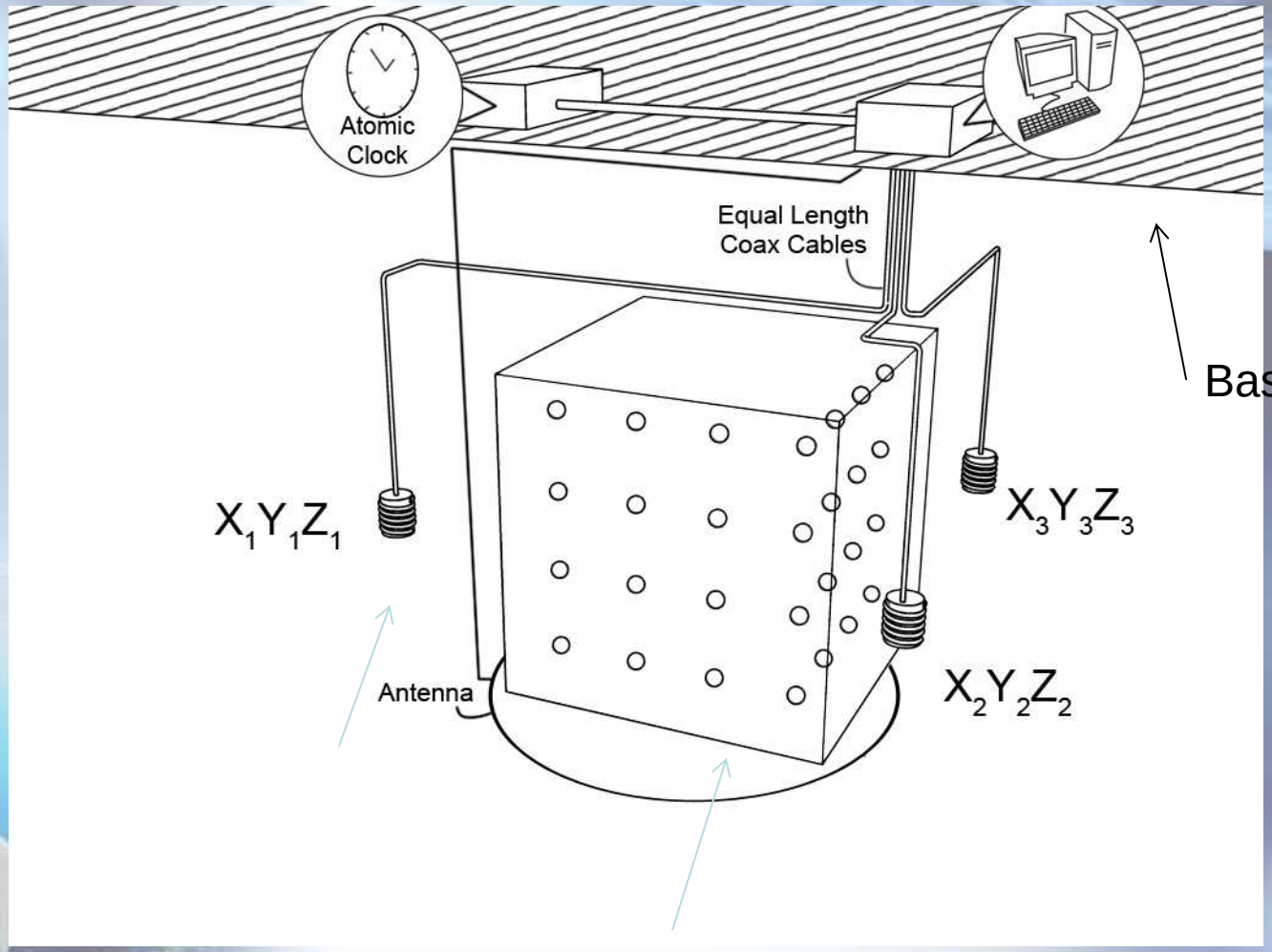
Initial SmartRocks Conceptual Idea

- Create a dynamic sensing system using synthetic rocks to determine location and path of flow within the rock mass of a block cave operation in real time
- Outcomes
  - Material Flow Monitoring System
  - Underground equivalent of GPS



Patent Pending

Smart Rocks System



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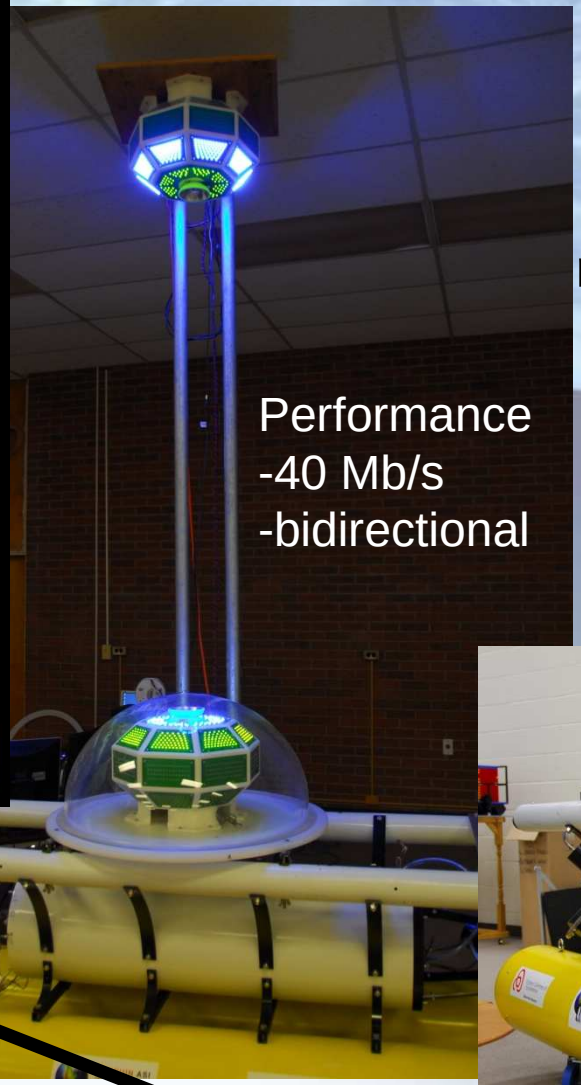
FREE SPACE OPTICAL COMMUNICATION

Optical Communication Technology



Teleoperation of an Untethered Robotic Submarine using our newly developed Optical Communication System

Performance
-40 Mb/s
-bidirectional

Latency Requirements 35 ms

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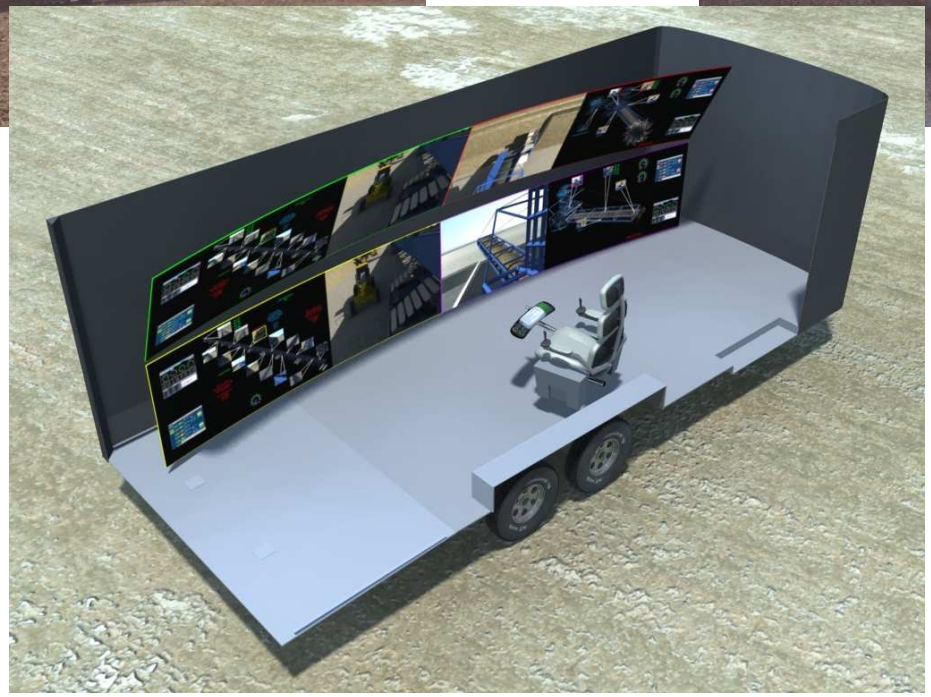
TELECOMMAND SPREADER/ROTOPALA

Stacker/Rotopala Telerobotics Project



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Del Pino INGENIEROS

CODELCO

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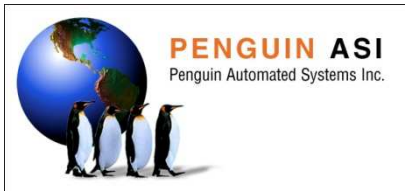
REMOTE LASER SCANNING AND INSPECTION

Long Distance Laser Scanning Robot System

- Purpose
  - Travel to unsafe conditions to inspect
- Current work
  - Travel into a mine 1.5 km where ground collapse is possible, no ventilation and no road maintenance
- Perform surveying and cavity scanning to assist the client in determining possibility of collapse

Telerobotic Multi-purpose Robot System

- System consists of
  - Telecommand Trailer with two workstations
  - Communications is done using Cisco Long Distance Antennas meshed with short range broad coverage antennas
  - Two Robots
    - Work Robot - Beaverbot
    - Communications Robot - Combot



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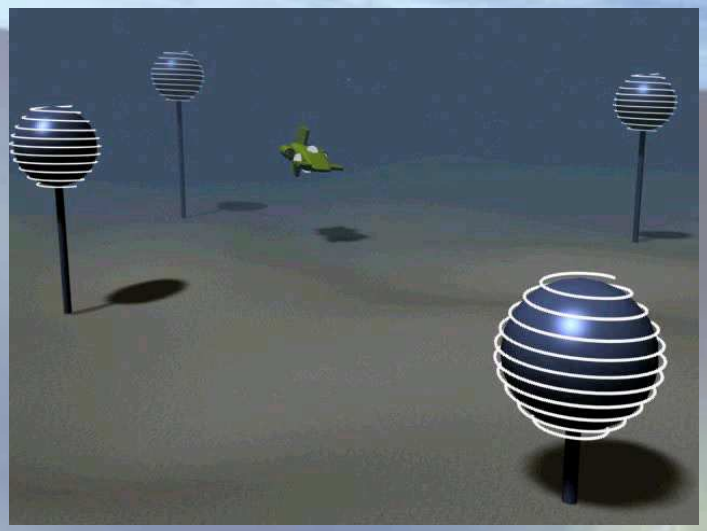
Thank You

www.penguinasi.com

www.gbaiden.laurentian.ca

Wireless Optical Cellular Communication Concept

- Radio Systems have difficulty functioning in surface environments due to regulation
- Develop a concept that:
  - Consists of a wireless optical network capable of transmitting/receiving multiple video, monitoring and control channels
- An underwater environment seemed ideal to constrain the problem



Patent Pending