Lunar Production Drilling Using WaterWitch
Adapting Terrestrial Technology to the design of a Lunar Production Drill
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PENGUIN ASI
Penguin Automated Systems Inc.
XISP inc.

Penguin Automated Systems Inc.
Developing Mining Robots for terrestrial and space applications

Dr. Baiden was the General Manager of R&D in Inco where he conceived of the manless mine.

This work began Dr. Baiden's Ph.D. thesis which developed and introduced of high speed, high capacity wireless networks for underground mining

The system demonstrated for the first time in the mining world the teleoperation of two Loaders in Toronto from Sudbury 400 km away

Penguin's Capability
– with knowledge of the next generation of terrestrial mining

- Exploration Techniques
- Delineation drilling
- Tunneling
- Drilling, Blasting, Mucking & Ground Support
- Mechanical rock cutting
- Reconnaissance
- Mapping and surveying
- Production Systems
- Drilling, loading, blasting and mucking
- Guidance Systems
- Power Systems
- Communications
- Non traditional positioning

We have the drilling, production mining knowledge to develop the proper robot systems for solving mining engineering challenges in any environments

Dr. Baiden's Work – Prior to Penguin

- 1988-1993 Thesis "A study in underground mine automation"
- Computer networking developed for mobile robot operation
- 1st economic study of viability
- World's first autonomous mine truck Little Stobie Mine, Sudbury with 2 years continuous operation (1989 to 1992)
- Demonstration of LHD operation from a surface control room (1992) which led to CIM demonstration 1 operator runs 2 LHDs for Toronto in Copper Cliff
- Telerobotic Control of Drilling from 700 km away with 1 Man operating 3 drills at a CIM demonstration Montreal to Sudbury
- Conceiving and Building of a Telerobotic Diamond Drill
- Mining Automation Project (MAP) was conceived 1993-1994

## Dr. Baiden's Work – Prior to Penguin

1995-2000 Mining Automation Program

- Consortium lead by Inco with Tamrock, Dyno Nobel & Canadian Government
- Research Mine established 1995
- Objective was the create a telerobotic mining pilot plant
- 2nd economic study of viability

All Mining Equipment was robotized by this program

- Diamond Drills
- Tunneling Drills
- Loading Equipment
- Trucking
- Ground Support
- Long Hole Drills

This led to the first prototype automated mine in the world

Mining Automation Program

Mining Technology is going through a major transformation

- Key Drivers are:
- Networking and Positioning
- Artificial Intelligence
- Advanced Sensing
- Pattern Recognition
- Emulated Reality
- Robot Coordination
- Cooperative Robotics
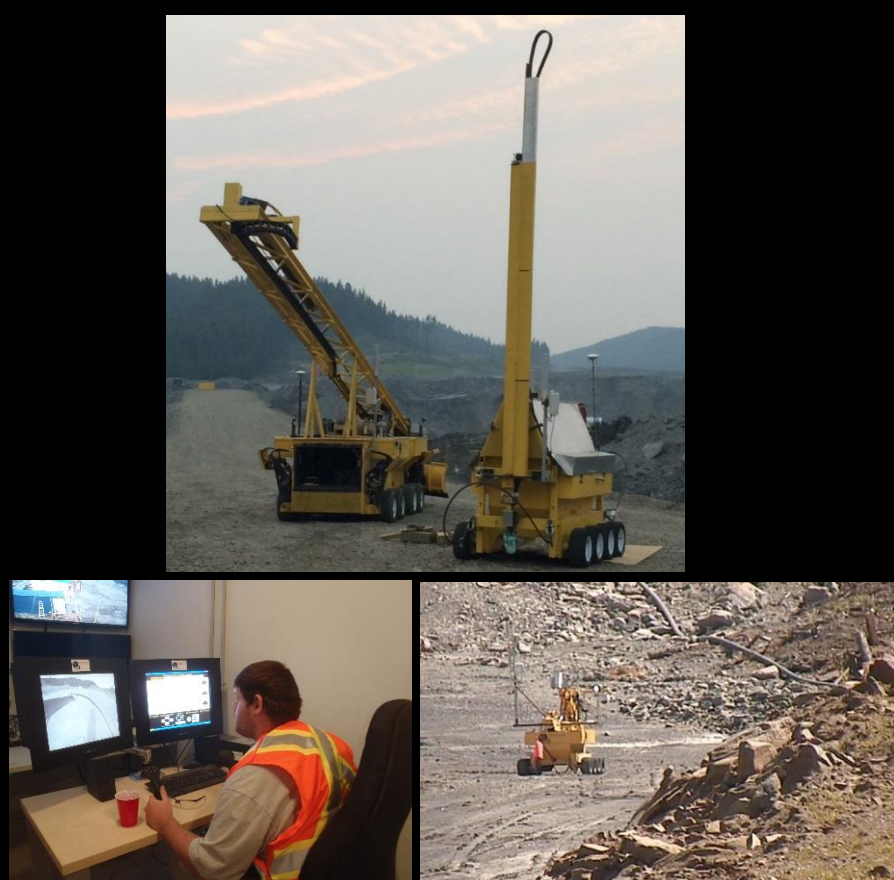
## What is driving the next generation change for mining?

Mine wide Networking Systems:
- RF
- WiFi
- LiFi
- Industrial Computing systems for Robots/Droids and Human Machine Interfaces (HMI)
- Subsurface positioning – Differential GPS equivalent for Underground
- Situational Awareness Systems
- Artificial Intelligence
- Robots and Droids

Telerobotic Communication Systems

- Now a mobile high bandwidth communication for teleoperation exists.
- This allows autonomation for mobile machinery!
- The principle is based on switching LEDs for transmission and detectors for receivers.
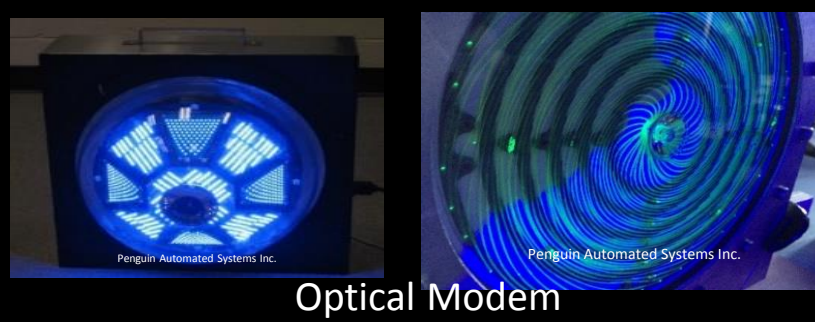
Optical Modem

Telerobotic Communication Systems

Optical Networking for the transfer of:
- Voice, data and video
- Allowing the concept figure to work
- Our testing has shown that a 2Gb/s optical network can be built for the teleoperation of surface equipment with near 0 latency

Tele-Reconnaissance System

- Create a system capable of underground facility mapping geospatially referenced to go where risk is unacceptable for humans
- Command Trailer
- Pair of telecommand workstations
- WIFI networking links
- Telecommunication
- Robot
- WIFI radio Links to trailer and work robot
- Work Robot
- Subsurface positioning unit and measurement profiling tools

The technology gathers precise geospatially mapped information

- Geologic assessment & joint structures
- Ground support location
- Overall drift and shaft location for stress analysis
- Ventilation assessment and calculation of new way of assessing surface roughness with the potential for energy reduction
- Assessment of over and under break
- The basis for a new mining machine control system
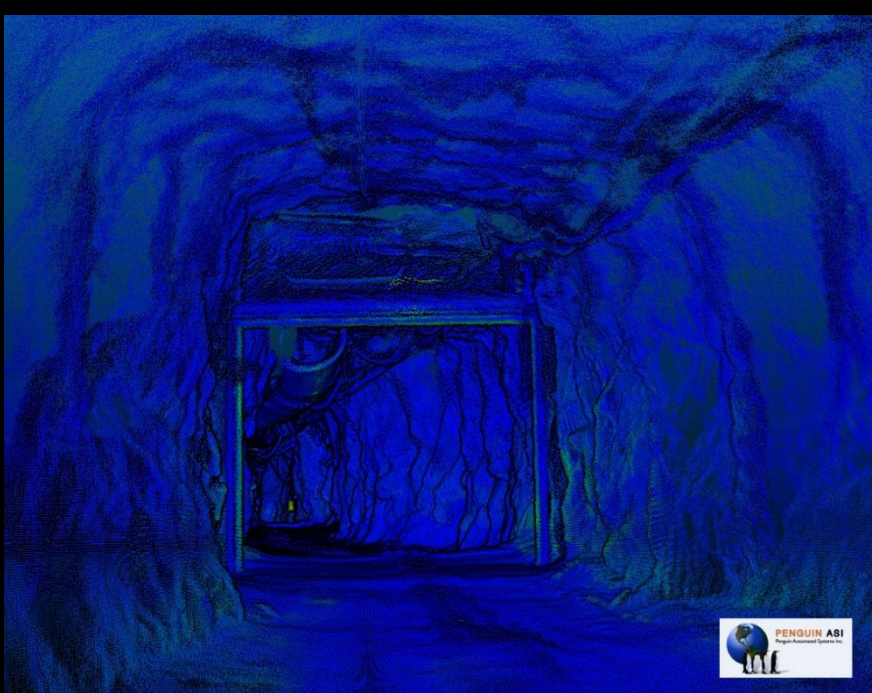
Hang-up Assessment and Removal TeleRobotic System
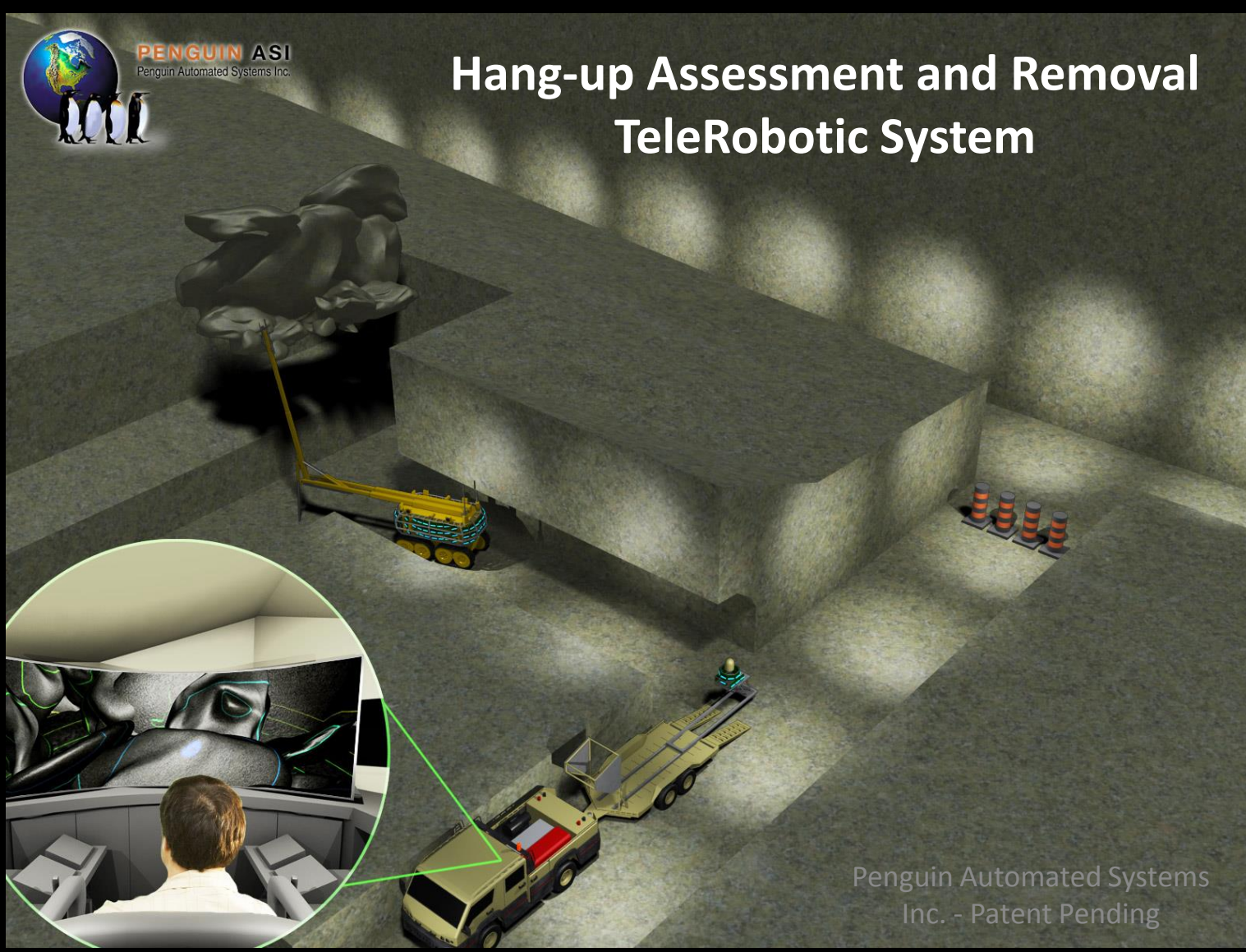
Penguin Automated Systems Inc. – Patent Pending

## Hang-up Assessment and Removal Robotic System

## TeleRobotic Blasthole Cleanup System

Problem
- Fully loaded blastholes with over 200,000 kg of explosives to be removed from a minimum of 600 metres away

Solution
- Three TeleRobot System
- Auger
- Robot Pumping/Picking Robot
- Communications Robot
- Container Complex
- Shipping, Maintenance and Telecommand Centre
- Telecommunications Infrastructure
- Satellite uplink
- Local High Capacity Wireless Network for Robot operation from 600 metres away
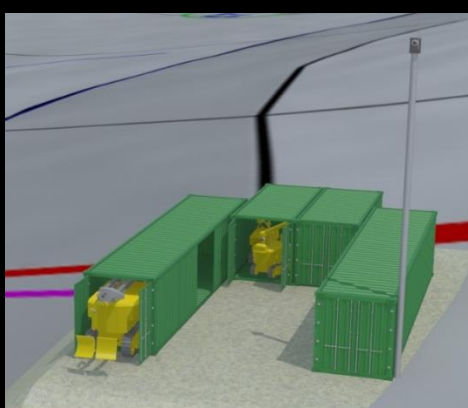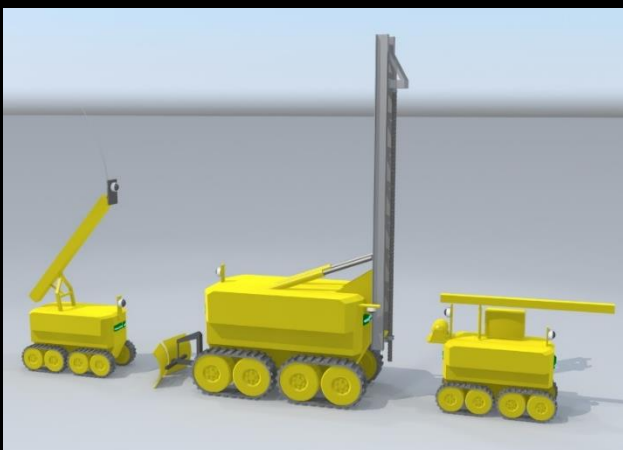
Auger and Communications Robot
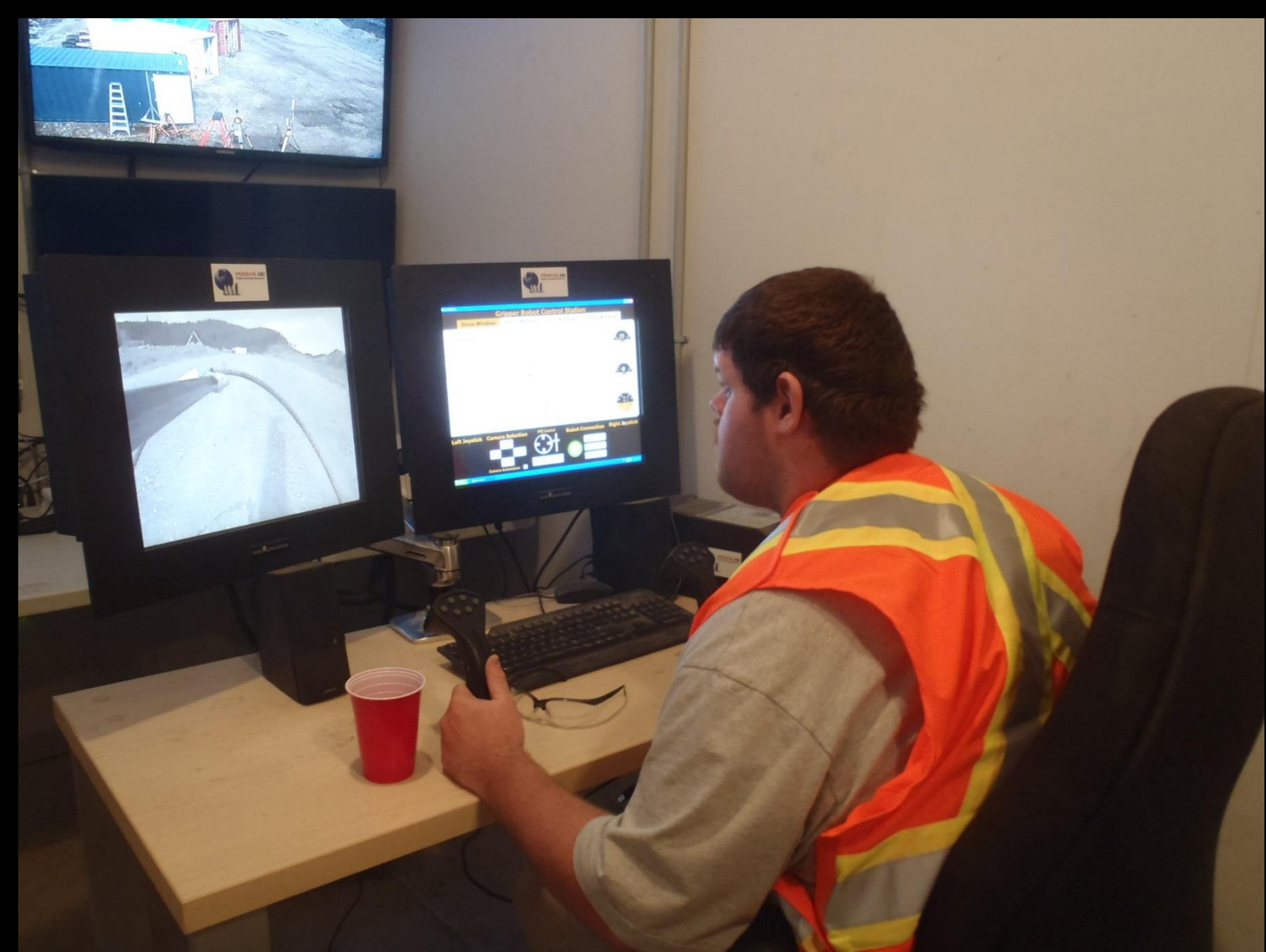
Lunar Mining

Penguin has developed these concepts from unique knowledge of the next generation in terrestrial mining robotics technology, Canadian Space Agency lunar mining conceptual work and with our Shackleton Mission Team from a senior miners perspective

Space excavation and mining techniques informed by terrestrial and lunar work to date
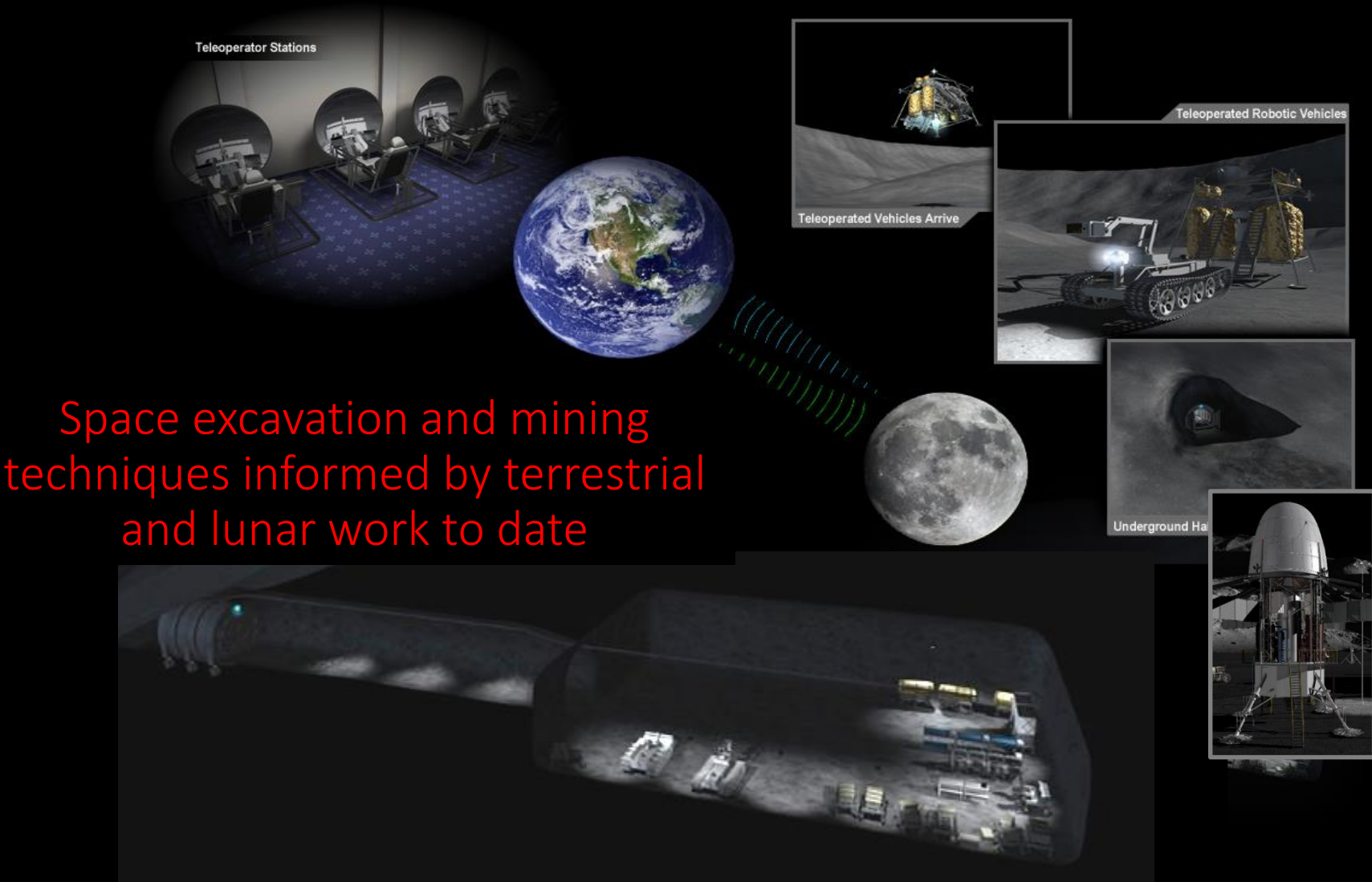
This briefing contains patent pending information belonging to Penguin ASI

Penguin has built on our patented lunar mining strategy provided to the Canadian Space Agency and worked with Shackleton Energy personnel to further hone the ideas based on input from key space players

The strategy proposes an entire exploration, base establishment, the key robotic pieces, earth to moon communications program. This work fits with the desire to launch of lunar water to Low Earth Orbit for fuel

Lunar Regolith Processor with XISP-Inc WaterWitch