GEOSPATIAL APPLICATIONS IN MINING: GENERAL VERSUS SPECIFIC ISSUES IN TECHNOLOGY

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Coal and Mining Session
India Geospatial Forum, Hyderabad
5 – 7 February 2014

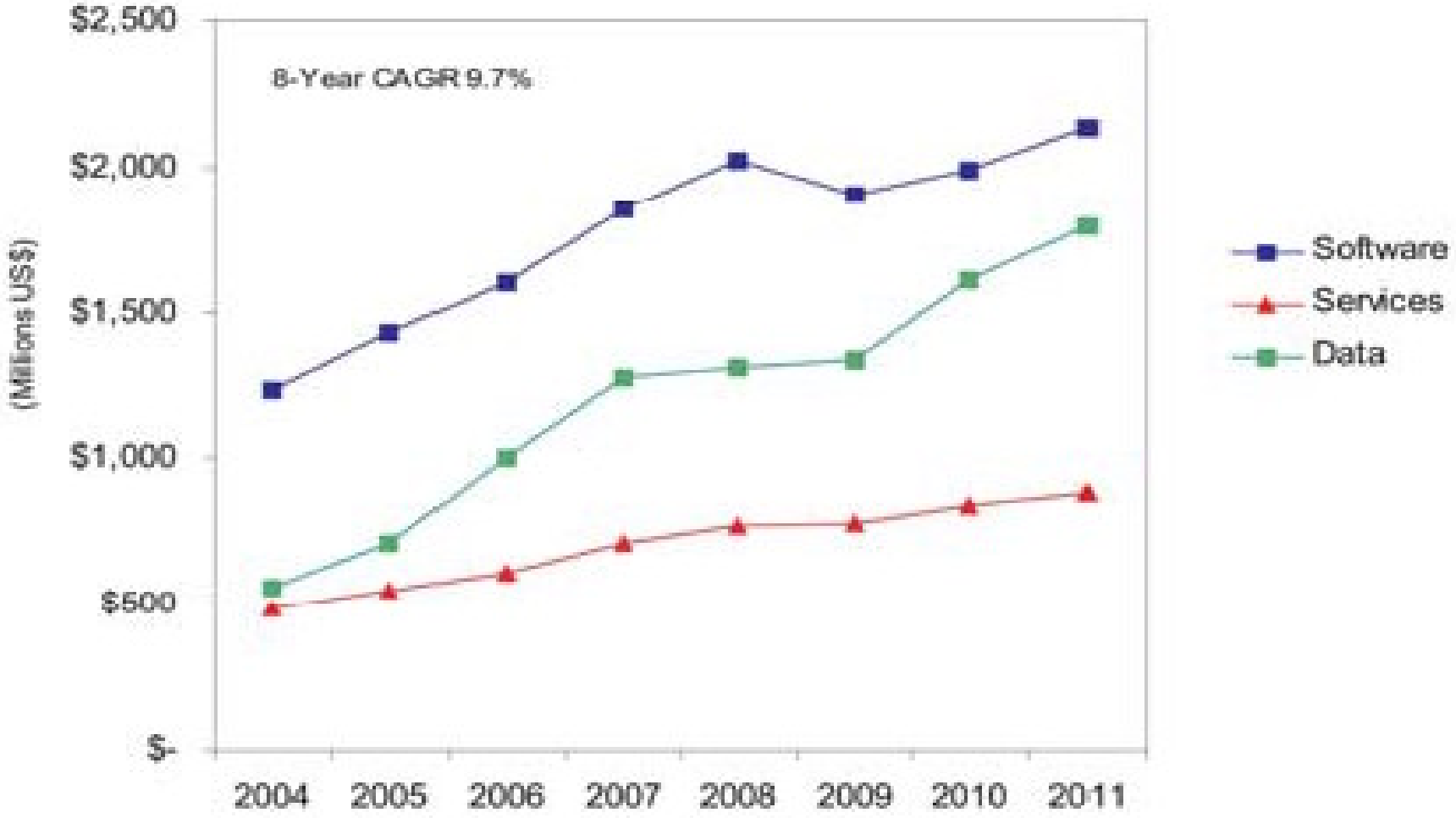
OUTLINE

- Geospatial Trends
- Mineral Industry Geospatial Data
- Mineral Industry Trends
- Mineral Development Cycle
- Emerging Technologies
- Future Mining Technology Needs

Domain of Geospatial Industry

- 1st Law of Geography – "Everything is related to everything else but near things are more related than distant things."
- Spatial or Geospatial Data
- Geospatial Software - GIS
- Geospatial Personnel – Developers, R&D, Companies, Consultants Technical and Non-technical Users, Educators, Etc.

GIS/Geospatial Industry Growth 2004-2011
Growth Analysis - Software, Services, and Data
Worldwide Revenue Estimates and Forecast



Ref.: GIS (1.6) 2011 DRAFT(060-175-070-135)-009bl

Domain of Geospatial Industry

- Applications in all areas of human Endeavor.
- Spatial Data Segment – Fastest Growing – 15.5% ACGR in 8 years
- Software and Services – 7.7% ACGR
- Early Applications – Mostly Planning and Design with Low Accuracies
- Emerging Applications – Day to Day Operational Issues with Higher Accuracies

MINE GEOSPATIAL DATA

- GEOLOGICAL MEDIUM – 1ST LAW OF GEOGRAPHY VERY RELEVANT
- DATA IS SPATIAL, GEOGRAPHICAL AND GEOLOGICAL, 3-D
- DATA IS MULTI-VARIATE
- NON-DISCRIMINATIVE AND DISCRIMINATIVE DATA

MINE GEOSPATIAL DATA

- DATA IS FROM SAMPLING AT DISCRETE LOCATIONS IN A CONTINOUS MEDIUM – SCALE, TIME, COST AND EFFORT VERY VARIABLE
- QUALITY OF DATA, PRIMARY AND SECONDARY DATA, AND AGGREGATED DATA
- DETERMINISTIC AND/OR STATISTICAL DATA

MINE GEOSPATIAL DATA

- NATURAL FACTORS INFLUENCING PROBLEM DEFINITION
- CULTURAL FACTORS INFLUENCING PROBLEM DEFINITION
- MULTIPLE LAYERS OF DATA AND OVERLAYING OF DATA LAYERS
- TOOLS, TECHNIQUES AND METHODS OF ANALYSIS

MINING GEOSPATIAL APPLICATIONS

- MINE LONG RANGE PLANNING AND DESIGN APPLICATIONS
- MINE OPERATIONAL PLANNING AND CONTROL APPLICATIONS
- NATURE OF DATA, TOOLS, TECHNOLOGY, AND PERSONNEL ARE DIFFERENT FOR THE TWO APPLICATIONS

MINERAL INDUSTRY TRENDS – MINING TECHNOLOGY

- CAPITAL REQUIREMENTS
- MINING CONDITIONS - CHALLENGING
- COMPANIES/SIZE OF MINES – BIGGER
- MINING EQUIPMENT – LARGER
- FOOTPRINT OF MINING – REDUCE
- NEW RULES AND REGULATIONS
- HUMAN RESOURCE NEEDS

MINING TECHNOLOGY

- A SIMPLE VIEW - A mine is a rock factory set up to extract mineral deposits wherever and whenever they are economic [mining technology].

- AN ENCOMPASSING VIEW - a human endeavor to utilize one of the natural resources of planet earth - mineral resources - for the benefit of mankind [mining technological system].


Interstate-15
tailings pond
road
terraces
tailings
Berkeley Pit
Butte
N

MINING TECHNOLOGY

THE SYSTEMS VIEW OF MINING TECHNOLOGY

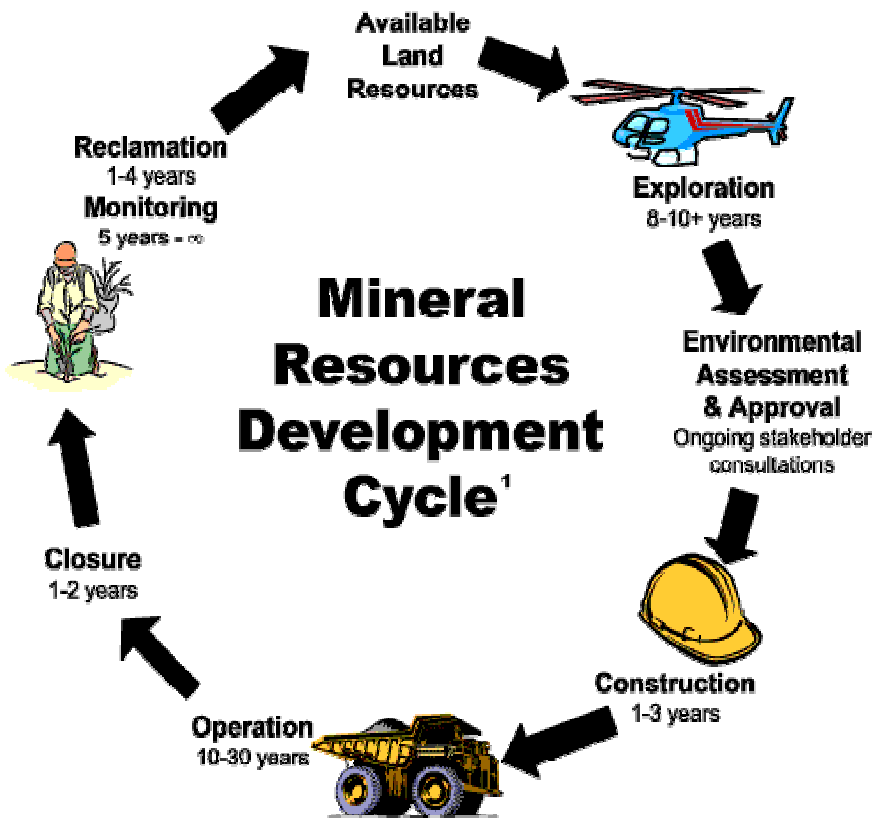
- INTERACTION OF NATURAL AND MAN-MADE SYSTEMS – LARGER CONTEXT
- MINING SYSTEMS, SUB-SYSTEMS, COMPONENTS, AND PARTS
- SPATIO-TEMPORAL CONSIDERATIONS
- A NUMBER OF LAYERS OF SPATIAL DATA
- HARDWARE AND SOFTWARE ISSUES
- PLANNING, DESIGNING AND OPERATING CONSIDERATIONS – PEOPLE

MAJOR MINING INDUSTRY PROBLEMS

A LARGE NUMBER OF PROBLEMS:

- FINDING ATTRACTIVE TARGETS
- OBTAINING LICENSE TO MINE
- OREBODY MODELING
- ORE RESERVE ESTIMATION
- LONG RANGE PLANNING AND SCHEDULING
- OPERATIONAL PLANNING, MONITORING AND CONTROL
- ENVIRONMENTAL PLANNING
- MINE CLOSURE

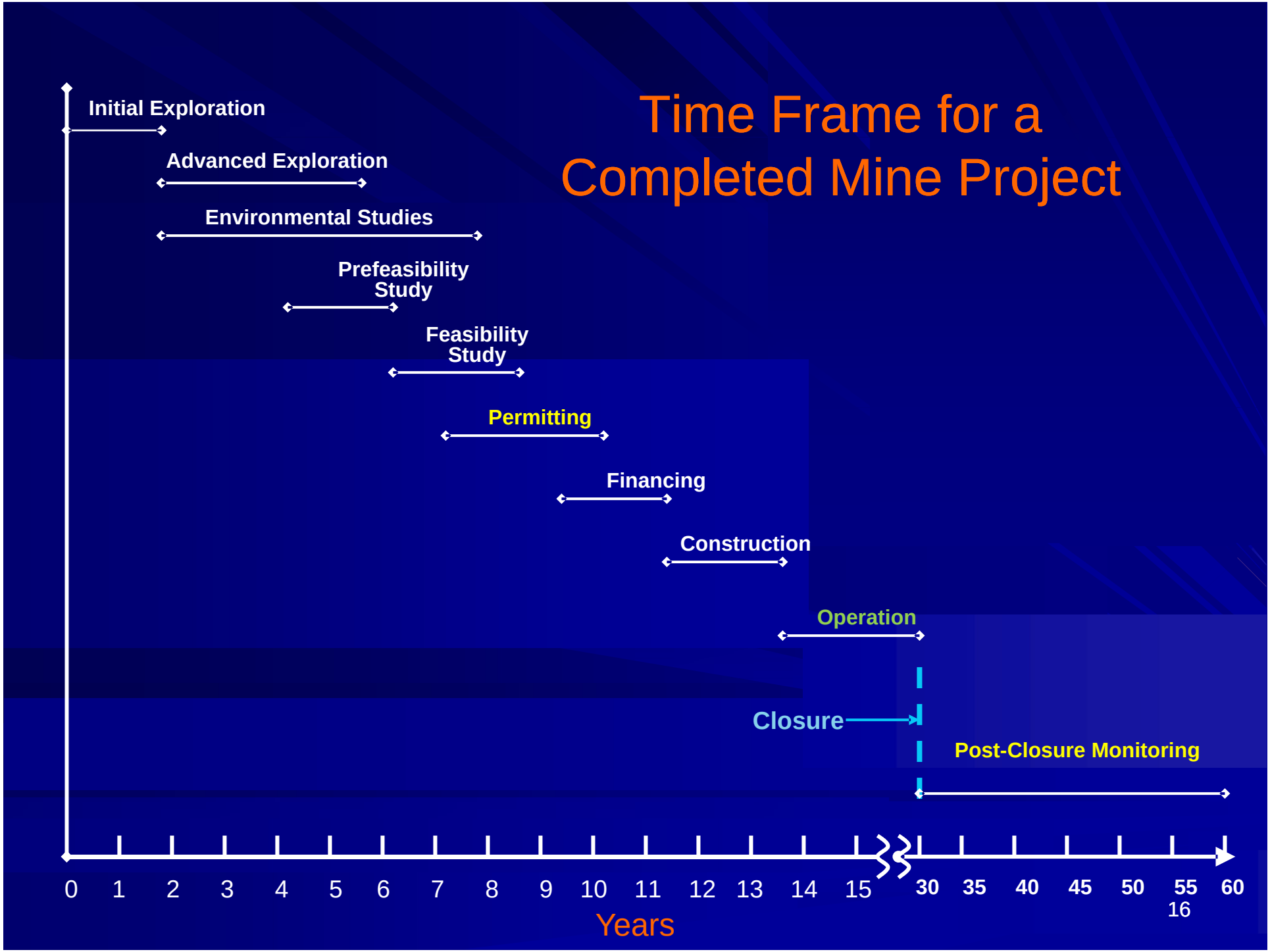
MINERAL DEVELOPMENT CYCLE



- PROSPECTING AND EXPLORATION
- MINE DEVELOPMENT
- EXTRACTION AND PRODUCTION
- MINE CLOSURE
- RECLAMATION AND REHABILITATION

Anderson, Phil. "Mineral Resources: Renewable & Nonrenewable." http://schoolworkhelper.net/. St. Rosemary Educational Institution, September 23, 2010. Web. Retrieved on: Wednesday 20th April 2011. http://schoolworkhelper.net/2010/09/mineral-resources-renewable-nonrenewable/.

Time Frame for a Completed Mine Project



EXPLORATION

- LIFE BLOOD OF MINING COMPANY
- GREAT POTENTIAL, VERY RISKY
- RESOURCES FOR EXPLORATION
- GEOSCIENCE RESEARCH
- NEW EXPLORATION TOOLS AND TECHNOLOGIES
- NEW ANALYSIS TOOLS/TECHNIQUES

GREAT POTENTIAL FOR GIS FOR KNOWLEDGE FROM DATA

EXTRACTION – UNIT OPERATIONS

REPETITIVE CYCLE CONSISTING OF

- DRILLING
- BLASTING
- LOADING
- HAULING
- RECLAMATION

EQUIPMENT AND METHODS

- TOP SOIL
- OVERBURDEN
- ORE
- NON-CONTINUOUS
- CONTINUOUS

SIGNIFICANT ADVANCES IN REALTIME MONITORING, AUTOMATIC MONITORING AND AUTONOMOUS CONTROL OF OPERATIONS.

DRILLING AND BLASTING

- FRAGMENTATION CRITICAL
- BLAST PATTERN
- ACCURACY OF DRILLING
- EXPLOSIVE TYPE AND LOADING
- GROUND VIBRATION
- HEALTH AND SAFETY
- DATA ACQUISITION DURING DRILLING
- RAPID EVALUATION OF DATA
- TECHNOLOGICAL ADVANCES

LOADING AND HAULING PRODUCTIVITY GAINS

- SIZE OF EQUIPMENT
- IN-PIT CRUSHING AND CONVEYING
- COMBINING SEVERAL UNIT OPERATIONS – LHDs
- CONTINUOUS MINING MACHINES
- CONTINUOUS HAULAGE
- INCREASED USE OF MONITORING AND AUTOMATED SYSTEMS

- CAPACITY: 400 TON
- EMPTY WEIGHT >620k KG
- MAX SPEED: 67 KM/H
- HORSEPOWER: 3550
- FUEL CAPACITY: 6814 L
- TIRE SIZE: 3.8 METERS
- PRICE: $5-6 MILLION

BUCKET CAPACITY: > 80 TONNES
HORSEPOWER: 4400
FUEL CAPACITY: 1600 LITRES
COST: $12 MILLION

MINE CLOSURE

PRINCIPAL ACTIVITIES

- THE OPEN-PIT
- WASTE ROCK DUMPS
- TAILINGS IMPOUNDMENTS
- WATER MANAGEMENT
- INFRASTRUCTURE COMPONENTS
- SOCIO-ECONOMIC ASPECTS

EMERGING COMPLEX TECHNOLOGICAL SYSTEMS

- The Nano-Bio-Info systems – smaller and smaller [space and time], increasing complexity
- The Energy-Environment-Food-Logistics-Communication systems – larger and larger, greater complexity
- The need is to incorporate the former in operations to manage the latter.

LAST TWO DECADES

- CELL PHONES, I-PHONES
- PCs, I-PADS
- E-MAIL
- WWW, GOOGLE, FACEBOOK
- VIDEO-CONFERENCE
- GPS, DIGITAL CAMERA
- VIRTUAL REALITY

GPS APPLICATIONS

- AN INTEGRAL PART OF SURFACE MINING
- REAL-TIME GUIDANCE OF MINING EQUIPMENT – DRILLS
- TRACKING MOBILE EQUIPMENT
- PRECISE POSITIONING OF EQUIPMENT – SHOVELS, TRUCKS
- ESSENTIAL FOR AUTOMATION

AUTONOMOUS MINING SYSTEMS

- REMOTE CONTROL
- AUTOMATIC CONTROL
- AUTONOMOUS OPERATION
- MANY SUCCESSFUL SYSTEMS – CONVEYORS, TRAINS, PIPELINES
- SURFACE MINING – LHDs, TRUCKs
- MACHINE HEALTH MONITORING
- INTERACTIONS OF THE VARIOUS SYSTEMS

PROGRESS TOWARDS AUTONOMOUS MINING

- HIGH PRECISION GPS AIDING LOCATION, POSITIONING, ETC
- MINE-WIDE MACHINE TO MACHINE COMMUNICATION NETWORK
- PROXIMITY DETECTION SYSTEMS
- EQUIPMENT CONDITION MONITORING
- HUMAN-MACHINE INTERFACE
- MAJOR EFFORT UNDERWAY IN R&D

UNIQUE MINING ISSUES

- LOOK-AHEAD TECHNOLOGIES FOR REAL-TIME DECISIONS - GEOPHYSICS
- MINING ENVIRONMENT – GEOLOGY, OPERATING CONDITIONS
- TASK REQUIREMENTS – NOT EASILY DEFINED
- MODELING HUMAN OPERATORS' COGNITIVE SKILLS – NOT EASY

SUMMARY

- BETTER RESERVE CHARACTERIZATION
- TOTAL RESOURCE CONSERVATION
- GREATER MINING RESERVE RECOVERY
- DEVELOP MORE CONTINUOUS MINING TECHNOLOGY
- ENHANCE PRODUCT RECOVERY AND MINED PRODUCT UTILIZATION

SUMMARY

- IMPROVE HEALTH, SAFETY AND WELFARE OF MINERS – STILL TOO UNSAFE..
- ACHIEVE GREATER PROGRESS ON AUTOMATED TECHOLOGIES.
- ENHANCE THE CONTRIBUTION OF THE OPERATION TO THE COMMUNITY AND GENERAL POPULATION.
- MEET THE ASPIRATIONS OF THE OWNERS. GOVERNMENT AND COMMUNITY.

SUMMARY

MAJOR PROBLEMS IN MINING STILL ARE:

- FINDING ATTRACTIVE TARGETS
- OREBODY MODELING
- ORE RESERVE ESTIMATION
- PRODUCTION PLANNING AND SCHEDULING
- ENVIRONMENTAL PLANNING
- MINE CLOSURE AND LAND USE PLANNING

ADVANCES IN TECHNOLOGY IS AN AID TO SOLVING THESE PROBLEMS.

SUMMARY

MAJOR ASPECTS IN SOLVING THESE PROBLEMS STILL ARE:

- TECHNICAL UNDERSTANDING OF THE PROBLEM.
- DATA THAT ARE APPROPRIATE AND RELIABLE.
- MODELS AND OTHER ANALYSES THAT ARE APPROPRIATE.
- OUTSTANDING MANAGERIAL SKILLS TO RECOGNIZE AND IMPLEMENT SUPERIOR SOLUTIONS.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