



Topics For Today

- A brief overview of the National Institute for Occupational Safety and Health/ Pittsburgh Research Laboratory
- A brief overview of US minerals mining
- A review of the NIOSH/DOE sponsored RAND Critical Issues in Mining Report



Pittsburgh Research Laboratory

- Providing practical solutions to real world occupational safety and health challenges



Pittsburgh Research Lab



- Pittsburgh, Pa
- Over 200 Employees
- 180 Acres
- Unique Facilities



Pittsburgh Research Lab

We are a unique combination of over 200 employees, representing wide range of disciplines, including engineering, epidemiology, industrial hygiene, chemistry, physics, geology, psychology and sociology, and world class facilities that enable it to address complex safety and health problems.

PRL: Safer - Healthier - Workers

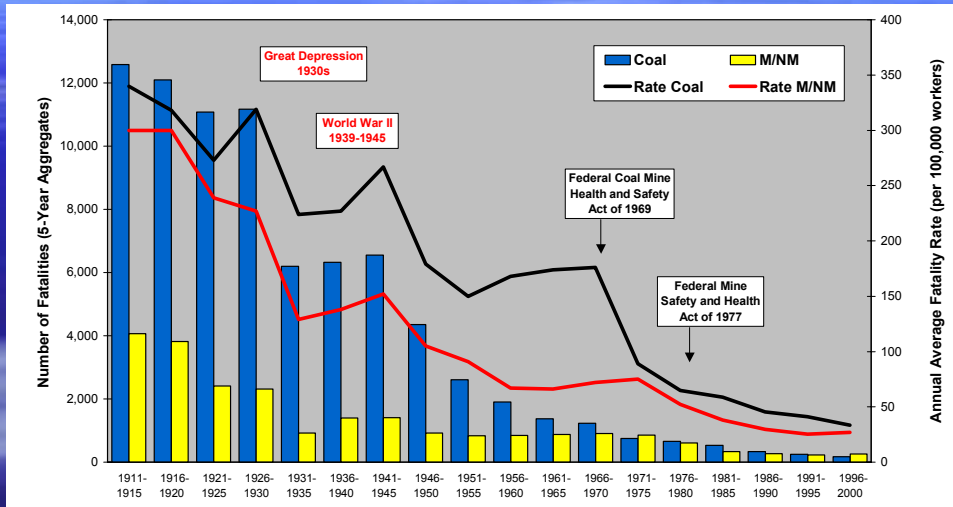
- **Proven** –
History of
Accomplishments
- **Presence** –
Strong & Lifesaving
- **Potential** –
Prepared to Address
Future Safety and
Health Threats



Idea Concept by Laroche College graphics students



Number of Fatalities and Annual Average Fatality Rates in the Mining Industry, 1911-2000



Source: USBM, MSHA



Shows the total number of fatalities (summed over 5-year periods) and the average annual fatality rate within each 5-year period from 1911-2000.

PRESENCE: The Research Program

- Diesel Monitoring and Control
- Dust Monitoring and Control
- Ergonomics & Machine Safety
- Fire Fighting & Prevention
- Hearing Loss Prevention & Engineering Noise Controls
- Emergency Response & Rescue
- Electrical Safety
- Explosives
- Ground Control
- Mine Ventilation
- Surveillance
- Training Research



Potential: Prepared to Address Future Safety and Health Threats

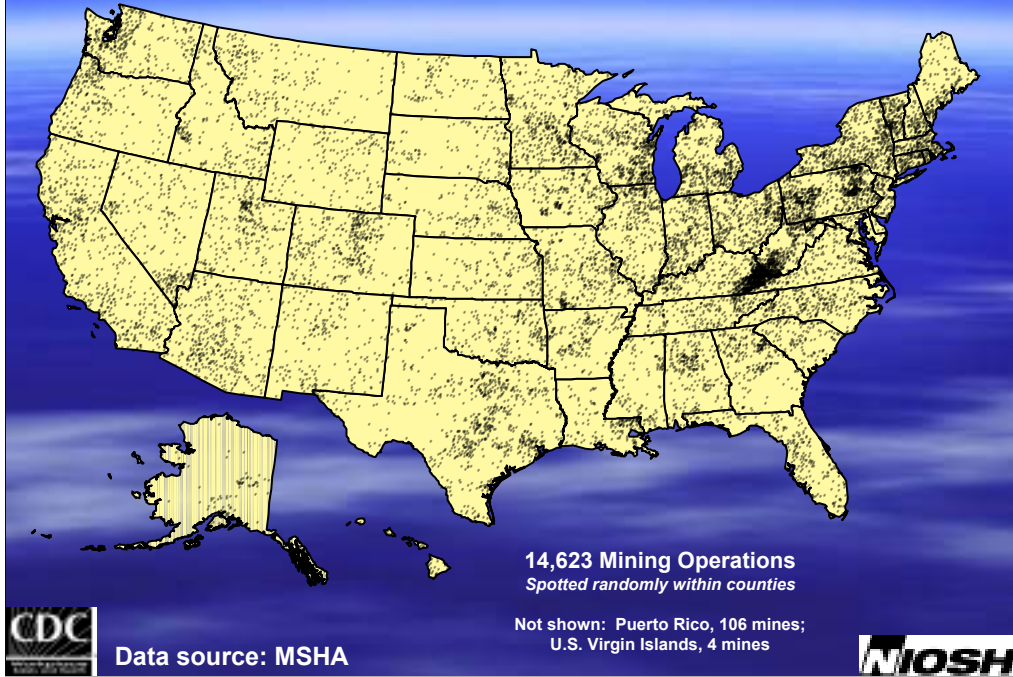
- World Class Expertise
- World Class Facilities
- Strong Constituencies
- Close Customer Communications
- Detailed Surveillance



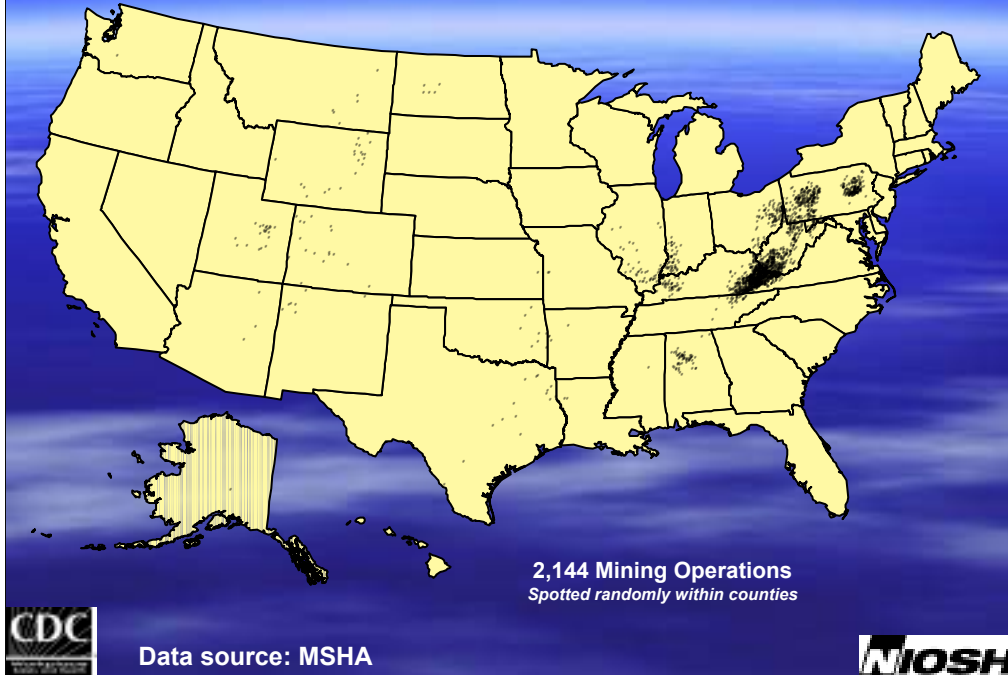
Mining in the United States



Mining Operations, 2001



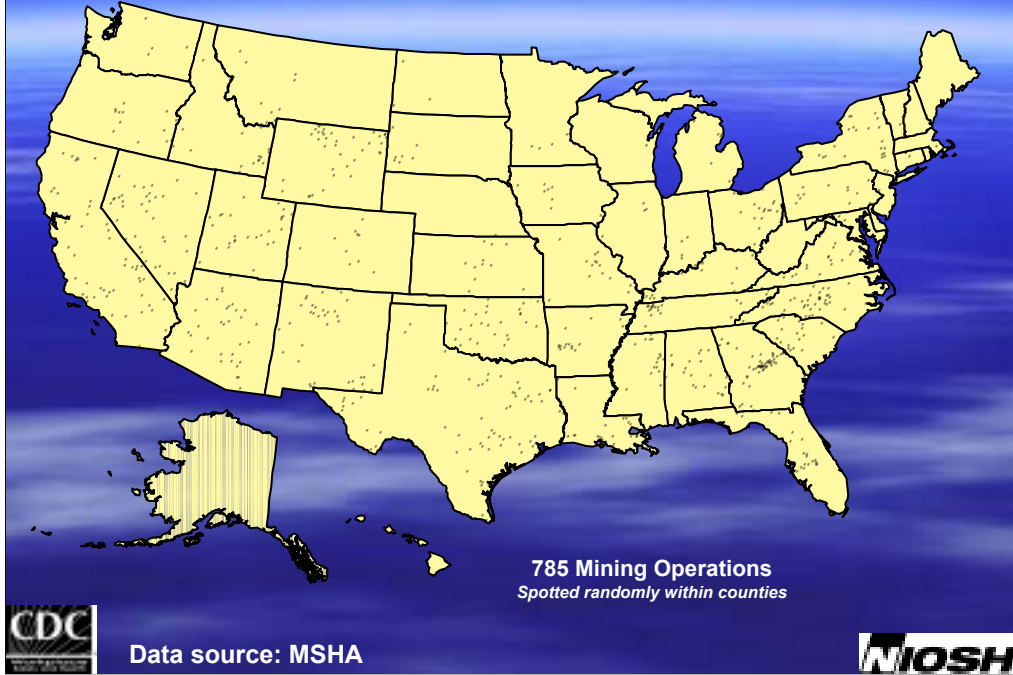
Coal Mining Operations, 2001



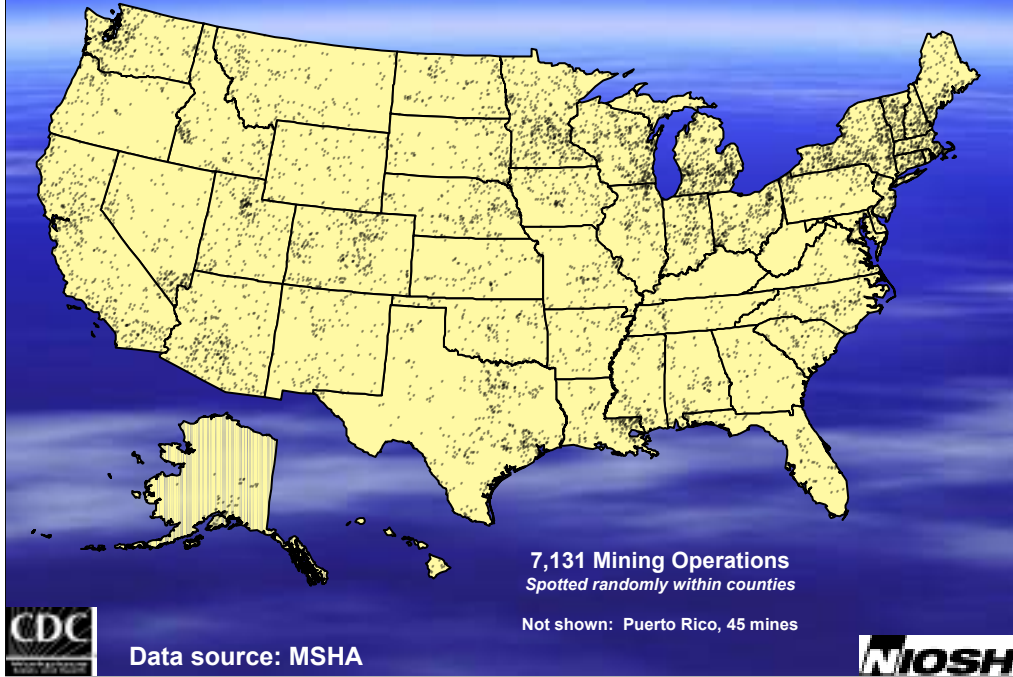
Metal Mining Operations, 2001



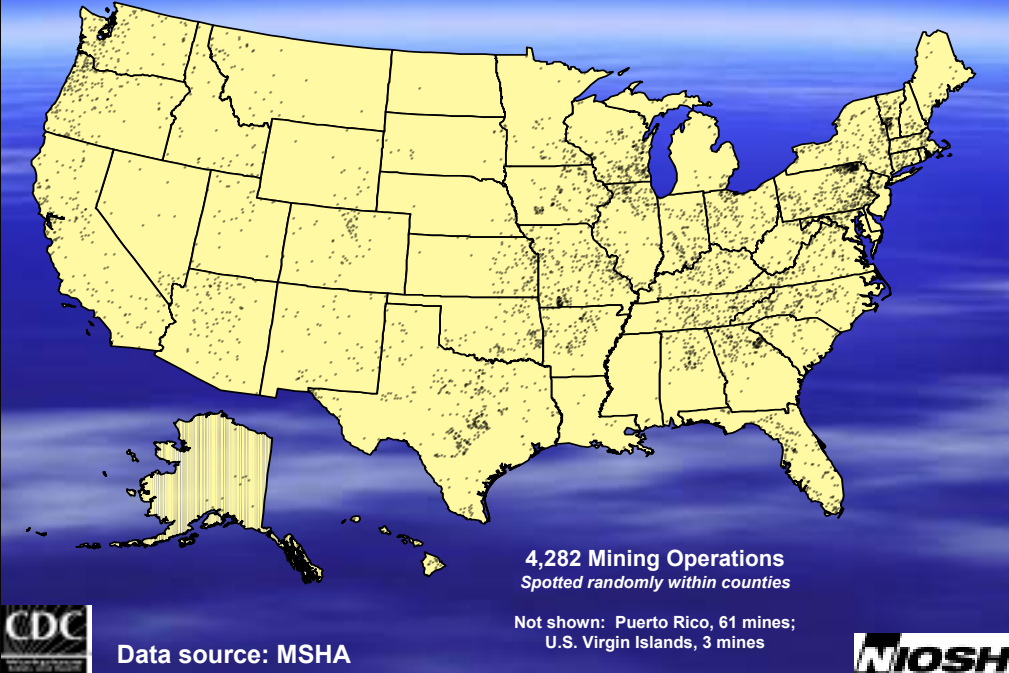
Nonmetal Mining Operations, 2001



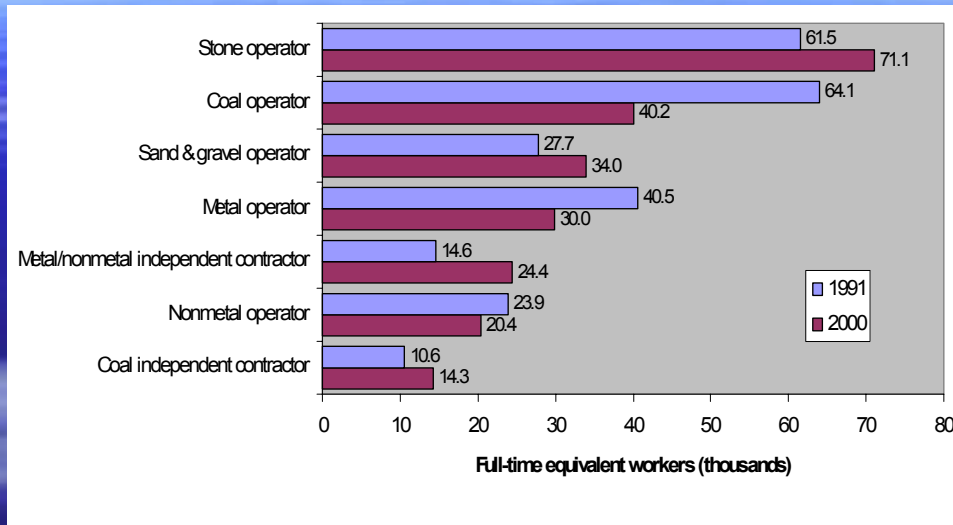
Sand & Gravel Mining Operations, 2001



Stone Mining Operations, 2001



**Number of Full-time Equivalent Workers* at
Surface Work Locations by Employer Type and Commodity
1991 versus 2000**

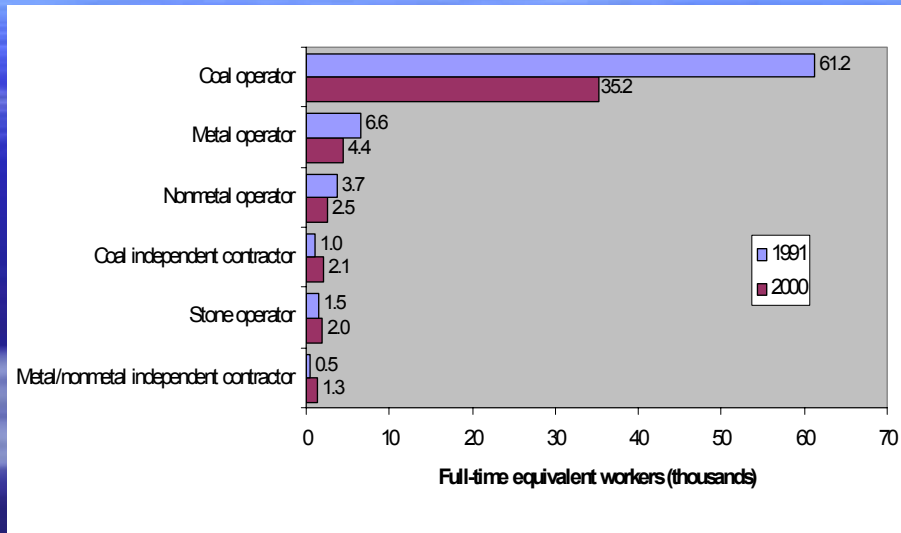


* Excludes office workers

Data source: MSHA



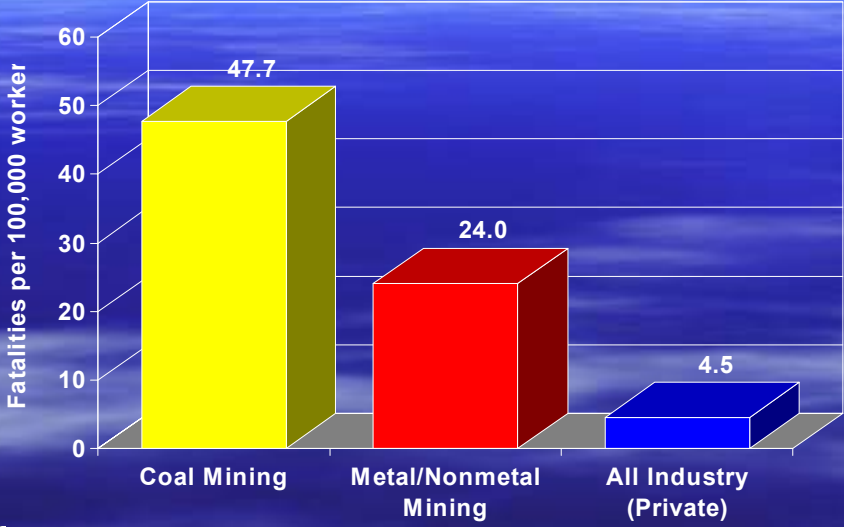
Number of Full-time Equivalent Workers* at
Underground Work Locations by Employer Type and Commodity
1991 versus 2000



Data source: MSHA * Excludes office workers



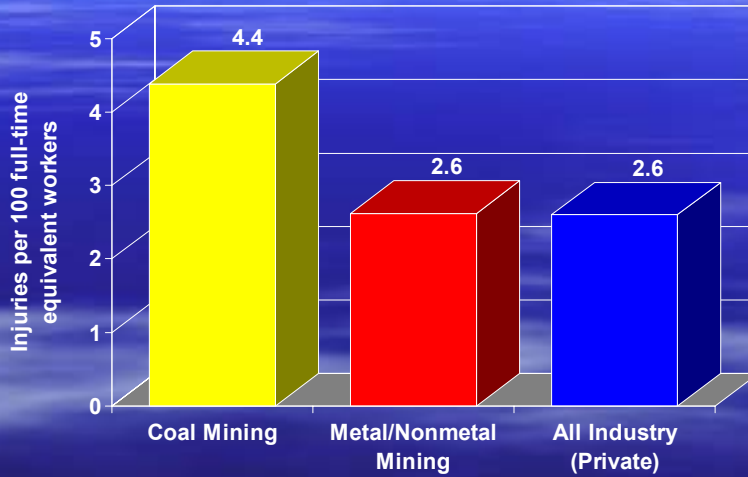
Fatality Rate in Coal Mining, Metal/Nonmetal Mining, and All Industry (Private), 2001



Data source: BLS



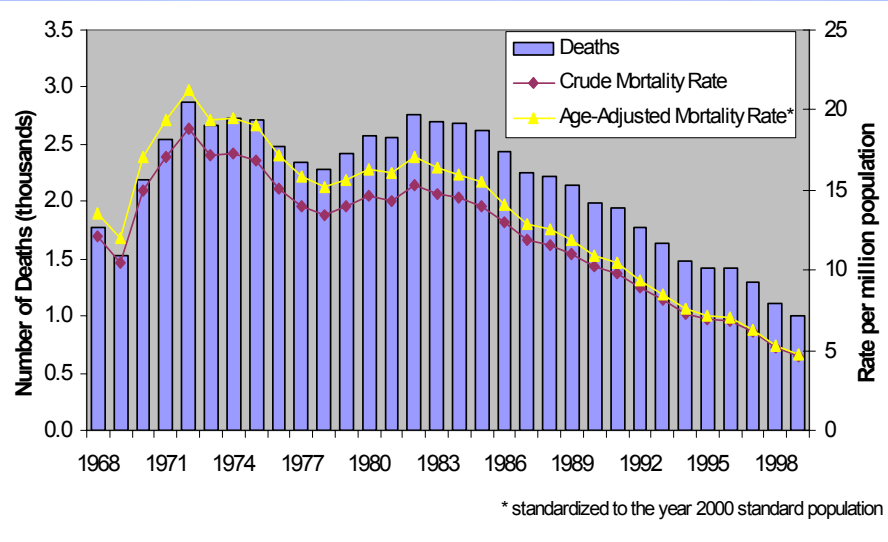
Nonfatal Lost-time Injury Rate in Coal Mining, Metal/Nonmetal Mining, and All Industry (Private), 2001



Data sources: MSHA; BLS



Coal Workers' Pneumoconiosis: Number of Deaths, Crude and Age-adjusted Mortality Rates, United States Residents



Data source: NCHS



New Forces at Work in Mining: Industry Views of Critical Technologies



DJ Peterson
Tom LaTourrette
James T. Bartis



About the Study

- **RAND**
 - An independent, non-profit research institution
- **The Task**
 - Conduct in-depth discussions with key members (“statesmen”) of the mining community
- **The Goal**
 - To identify those technologies critical to the success of their operations now and over the coming decade



Who Requested the Study?

- NIOSH: National Occupational Research Agenda
 - Identified “emerging technologies” as a priority topic for research
 - Proactive effort to anticipate hazards rather than respond to accidents
- DOE Mining Industry of the Future
 - Identifying technology needs & research priorities for government and industry
 - Consensus-building process



A Range of Organizations Participated

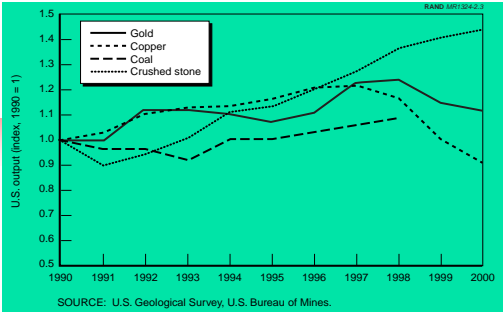
COAL (8)	METALS (11)	MATERIALS (4)	TECHNOLOGIES & SERVICES (29)	RESEARCH & OTHER (7)
American Coal Company	ASARCO	US Borax	Atlas Copco Wagner	Carnegie-Mellon Robotics Institute
American Electric Power	Barrick	Hanson Aggregates	Austin Powder	Colorado School of Mines
Arch Coal	Canyon Resources	Martin Marietta Materials	Bucyrus	MIRARC O / Laurentian University
A.T. Massey	Cleveland Cliffs	Vulcan Materials	Caterpillar	Pennsylvania DEP
CONSOL	Echo Bay Mines		Dyno Nobel	University of Arizona
Interwest Mining	Hecla		ExxonMobil Lubricants	University of Utah
Peabody	Homestake		Fosroc	Virginia Polytechnic Institute
Jim Walter Resources	Inco		Goodyear	
	Kennecott Utah Copper		P&H	
	Newmont		Joy	
	Phelps-Dodge		Komatsu	
			Master Builders	
			Modular Mining Systems	
			Orica	
			Sandvik Tamrock	
			Trimble Navigation	
			Others...	

**58 organizations
90+ individuals**

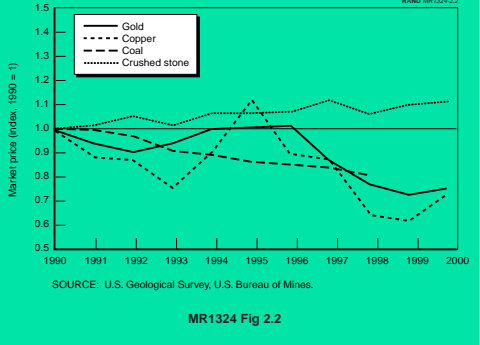


Industry Views of Important Trends

The Mining Industry, 1990s



*Production went up,
most prices went down*



Mining is a Risk-Averse Sector

- Little spending on R&D
 - In-house R&D programs have been shut down
 - “R&D” targeted to site-specific problem-solving
- Wariness of unknown technologies & those requiring large capital commitments
- Breakthrough innovations require sustained and collaborative R&D efforts
- Result: Current innovations are incremental



Regulation is not Critical

- *Not* mentioned as a leading technology driver
- Main concerns when asked
 - Diesel emissions
 - Dust (ambient & occupational)
 - Noise
- Two views on compliance
 - Technology solutions will be available (diesel)
 - See no technology solutions (dust, noise)
- Entitlement *is* the issue
 - Realm of politics, not technology



Few New Facilities are being Developed

- Mining entitlement process in the US is complex, lengthy, and costly (~10 years)
- Existing facilities are being reengineered
 - Going deeper
 - Going underground
 - More thorough extraction
 - Reducing footprint to access to new reserves
- Result: Newer mines abroad are often seen as technology leaders



Stone & Aggregates is an Exception

- Strong demand scenario
- Permitting issues are pushing the number of quarries down and their average size up
- New product specifications call for better crushing and screening technologies
- Result: Quarries may see some of the greatest technology advances in the future





Industry Views of Critical Technologies

Bigger, Stronger, Faster Equipment

- Larger capacity machinery
 - 340-400 ton trucks now; 1000 tons < 20 years
 - 50 yard³ shovels now; 150 yard³ < 20 years
 - Faster, more powerful conveyors, crushers
- Implications
 - Health & Safety (noise, visibility)
 - Facility scale-up (roads, other equipment)
 - Maintenance (larger sheds, mechanical assists)
- Question: Is bigger better? Trade-offs on reliability, shipping costs, and field assembly



Emerging Unit-Ops Innovations

- Blasting
 - Trend from packaged to bulk products
 - High-precision delivery vehicles
 - Electronic detonation
- Mechanical cutting of hard rock
 - Alternative to blasting in narrow-vein operations
 - May increase noise and dust problems
- Ground control
 - Bolter miners
 - Cable bolts
 - Advanced shotcrete mixtures



The Bottom Line on Unit-Ops

- Changes in basic unit-ops equipment at mine sites will be fairly incremental, linear, and predictable



- What will change:
–*How you run it,
control it, monitor it,
and utilize it.*



Information Technologies are Critical

- Sensors
 - Equipment status (tire pressure/temp)
 - Duty cycle (excessive speed/revs)
 - Hazards (proximity)
 - Geological (rock anomaly/deformation)
- Computers
 - Cheaper & more powerful
 - Ruggedized
- Result: Real-time decision making
- Concern: Knowledge management—
–Data is not as interesting as insight.



Communications is Critical

- Wired and wireless systems
- High-resolution GPS
- Results:
 - Real-time & remote decision making
 - Automated dispatch, surveying, placement
 - Faster break-down & emergency response
 - Remote controls
 - Process integration (tying unit-ops together)
 - Process intervention (layering-in support)



Autonomous Equipment Looks Promising

- Viewed by leaders as “the next big step”
 - Reducing operator-induced wear-and-tear
 - Increasing equipment utilization
 - Reducing labor costs
- Expected availability
 - Surface haul trucks: 2002-2005
 - Drills: 2003
 - LHDs: 2005
 - Shovels: 2005



Uncertainty about Autonomous Equipment

- Slowed by the complex mine environment
 - *The technologies for driving machines have been around for a long time. But to do this with high reliability 24/7 is very hard.*
- Questions:
 - Where will it be adopted first?
 - Is ventilation needed?
 - Role of mine personnel
 - Is it worth the cost?
- Result: Semi-autonomous systems are an intermediate step (drilling, U.G. haulage)



Maintenance is Critical

- Better engineering (robust systems, easy access ports, modular components)
- Better facilities and practices
 - On-site: cleaner, more careful
 - Off-site: specialized facilities, diagnostics
- Trend towards predictive maintenance
- Results:
 - Maintenance done only when necessary
 - Problems predictable and detected earlier
 - Can better control the “terms of engagement”



Human Resources is Critical

- Decision-making is being pushed downwards
- Roles are changing from following rules to solving problems
- Hard to compete for and retain qualified personnel in a “bricks and mortar” industry
- A safe and enjoyable workplace helps attract, retain, and motivate employees
- Result: People are *more* critical
- Challenge: *Getting people to think.*



Management Matters

- On predictive maintenance—
“Changing the way we’ve done it for the last 40 years” requires “selling the program to the people.”
- On boosting productivity—
“We did it not by buying new equipment, but by motivating the workforce.”
- On mission success—
“Technology won’t solve problems. It’s a combination of technology and people.”



Many Questions Remain Open

- Tech views in the industry are very diverse
- Where to invest in productivity enhancements?
—*Improvements on the back end have a big impact on the front end.*
- How do you measure benefits of new techs?
—*It's surprising to find an operation that understands their costs from beginning to end.*
- Who is responsible for new technologies?
—*You need everyone at the table to work things out.*



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