

# Industrial Technologies Program

## Total Ore Process Integration and Management (TOPIM)

### TOPIM Strategy Will Help Increase Efficiency and Lower Costs in all Phases of Comminution

Currently, the mining industry uses much of its electrical energy for size reduction of all mineral ores. A reduction of even 10 percent of the comminution energy consumption offers tremendous potential for both energy savings and productivity increases.

The problem with controlling any complex and constantly changing industrial process is that no single current technology is sufficient to ensure optimal operation. Historically, mining and mineral processing have been optimized as individual unit operations, but not together as a whole. To truly optimize mineral liberation at a particular site, a more unified approach must be taken. It is important to analyze the component operations as a continuum. Thorough characterization of the results of blasting, crushing and grinding would provide information for improvements up and down the ore stream.

This project aims to lower energy costs in all phases of comminution (blasting, crushing and grinding) through better understanding and monitoring of the overall mining process. In order to achieve this goal, researchers at the University of Missouri-Rolla and its partners are developing a Total Ore Processing Integration and Management System (TOPIM). TOPIM will apply information management and system optimization to the entire mineral-processing stream. This will allow mill and mine personnel to reach and maintain peak efficiency, in spite of changing ore body conditions. In order to implement the TOPIM strategy, detailed investigations into a variety of rock and process properties from each step in mineral preparation (drilling, blasting, mucking, crushing and grinding) will be conducted. These properties (e.g. rock strength, drillability, microfractures, powder factor, particle sizes, etc.) measured at each

process step will be analyzed to determine their effects on size reduction. When a controlling factor is found, a simple measurement system will be identified. Measurements of the controlling factor will then be modeled and used for direct processing actions. TOPIM will initially be focused on comminution, but will ultimately expand the scope to physical and chemical separation steps for the entire ore stream.

There will be many benefits in utilizing the TOPIM strategy. More efficient response of the mining and milling process to in situ variations of the ore ultimately means less energy expended to generate a given unit of production. Lower energy use also means lower environmental impact by preventing contamination of groundwater, surface waters, and air. Increasing the efficiency of ore fragmentation leads to more effective separation of minerals from waste rock. Loading, hauling, crushing, and grinding equipment also wears more slowly when handling well-blasted rock, thereby slowing the release of heavy metals from wear-part alloys. Finally, augmenting comminution efficiency should reduce fines generation, which will minimize worker exposure to grinding dusts and respirable fines.



### Benefits for Our Industry and Our Nation

- *Expected to reduce comminution energy consumption by 10%.*
- *Lowers environmental impact; including less contamination in air, water and waste.*
- *Improvements to worker health and safety by reducing levels of grinding dusts and respirable fines, and lower exposure to hazardous situations.*

### Applications in Our Nation's Industry

The TOPIM System can be adopted by nonmetals, fuels, industrial minerals and quarrying mines. The competitiveness of all types of U.S. mining will increase, improving the competitiveness of their client industries, such as manufacturing. The end result is foreseen as better products at lower costs, freeing capital for other uses in the United States.

## Project Description

Goal: To reduce comminution energy requirements in the mine and mill by 10 percent by developing the TOPIM System, a data management and planning tool for mine and mill personnel designed to enhance continuous optimization of the ore process stream on a near-real-time basis, as the geology of the ore changes.

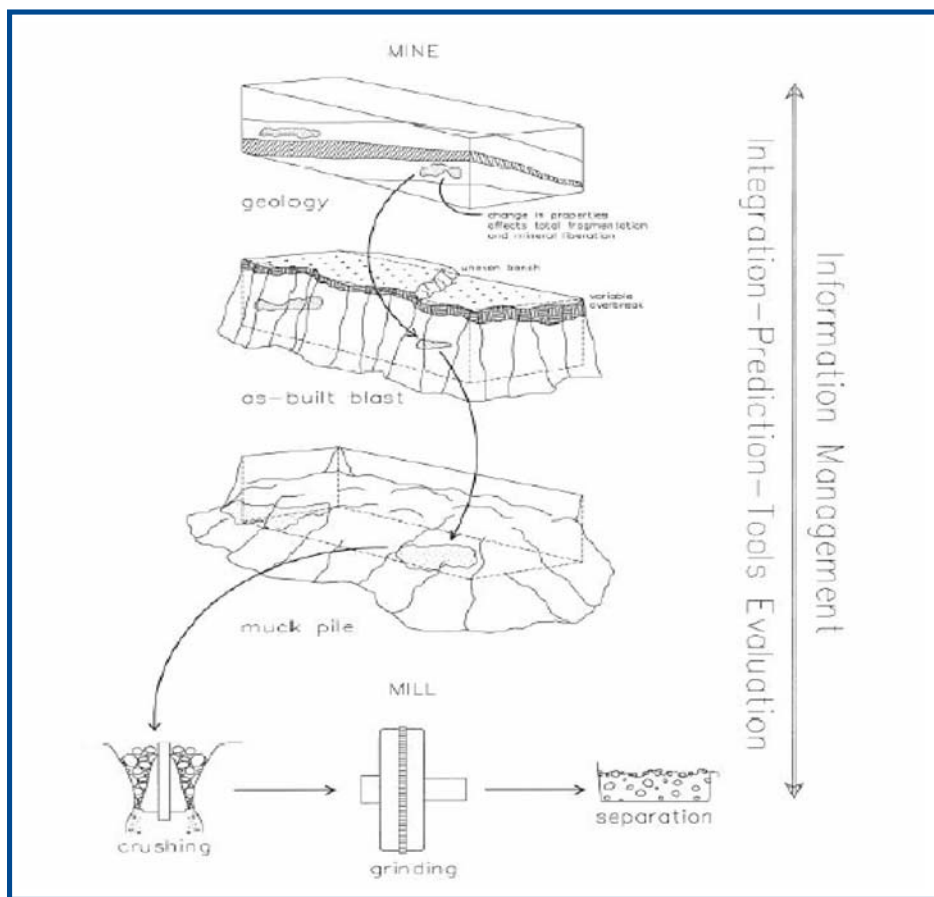
The project management team will utilize all available means to reach maximum commercialization. This includes presentations at industry conferences, articles in scholarly journals and industrial publications, and use of Web sites. The likelihood of widespread commercial implementation is high, since the participating mining companies account for major fractions of domestic U.S. iron and copper production.

## Milestones

- Determine in situ physical properties of the rock control comminution for iron and copper ores.
- Develop inexpensive and easy-to-implement techniques to measure/monitor these properties.
- Establish a methodology to turn the information into a shot-by-shot comminution control system suitable for daily production use (the TOPIM System).
- Develop marketing or dissemination plan for the TOPIM system.

## Project Partners

- University of Missouri-Rolla  
Rolla, MO
- University of Arizona  
Tucson, AZ
- U.S. Steel Corp. / Minntac Mine  
Mountain Iron, MN
- Cleveland-Cliffs Inc. / Empire or Tilden Mine  
Cleveland, OH
- Phelps Dodge Corp. / Sierrita Mine  
Green Valley, AZ
- Eloranta Assoc.  
Tower, MN
- Mount Sopris Instruments  
Golden, CO
- Viking Explosives  
Rosemount, MN
- Pepin Ireco  
Ishpeming, MI
- Split Engineering  
Tucson, AZ
- Metso Minerals  
Tampere, Finland
- Thunderbird Pacific/Tritronics Inc.  
Abingdon, MD
- Mintec Inc.  
Tucson, AZ
- Baker Hughes-KnowledgeScape  
Salt Lake City, UT



**Schematic diagram of the TOPIM System concept.**

## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy  
Energy Efficiency  
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