PROCEEDINGS

OF THE

ILLINOIS MINING INSTITUTE

FOUNDED FEBRUARY 1892

1998

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Gregg Bierei

PRESIDENT 1997-98

THE COAL MINER

TRUE—he plays no grandstand role in life
But his importance is vital, great and just:
For without his toil in earth's caverns deep,
Civilization would soon crumble into the dust.
AD 1964 From his poem – Vachel Davis

(Dedicated on State Capitol Lawn, Springfield, Illinois, October 16, 1964)

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PROCEEDINGS
OF THE
ILLINOIS MINING INSTITUTE

ANNUAL MEETING
106th YEAR
Collinsville, Illinois
Thursday and Friday, September 24-25, 1998

The opening session of the 106th Annual Meeting of the Illinois Mining Institute was convened at 10:00 A.M., Thursday, September 24, 1998, in the Mississippian Room of the Gateway Center. Gregg Bierei, President of the Institute, presided.

OPENING REMARKS

Gregg Bierei: My name is Gregg Bierei. I would like to welcome you to the 106th annual meeting of the Illinois Mining Institute. I think we have a very good program put together this year. As everybody knows, the industry is changing, and with consolidation and the current situation across the country, meetings like this will allow us to gain some information that will be helpful to everyone and hopefully keep us all competitive here in the future.

Allow me to go through some announcements for the day. The luncheon is on Friday; it will be at noon in ballroom A which is next to the exhibit hall. The luncheon speaker will be Andy Blumenfeld with Arch Coal. He will give us his perspective on the marketing situation here in Illinois. Awards will be given by the Illinois Office of Mines and Minerals; they include the annual reclamation and safety awards.

A reminder that tonight, Thursday, from 5:00 to 7:00, there will be a fellowship in the exhibit hall. We encourage everyone to enjoy the food and drinks and meet old friends and have a good get-together.

The business meeting will be Friday morning at 9:00 a.m. in the Mississippian Room, and we ask everybody to attend if possible. We have some important decisions to make this year, including the election of officers and board members, discussion of our finances and review of our scholarship awards for the coming year.

Also, if anyone is aware of a member of the IMI who has passed away in the past year, we would like to have their names. Please inform either Heinz Damberger or Phyllis Godwin so they can be recognized during the luncheon on Friday.

I would like to point out that there will be a guard in front of the exhibit hall and anyone who wishes to enter must be registered and have a name tag.

We have solicited some donations this year from members, and I would like to recognize those for their special donations: A-Z Industries, Arch of Illinois, Frontier-Kemper Constructors, The Illinois Department of Commerce and Community Affairs, Peabody Coal, Sugar Camp Coal, Consolidation Coal Company and UMWA District 12. I would like to thank everyone for their support during the year.

We do have raffle tickets available for two airplane tickets to anywhere in the contiguous United States and a set of golf clubs. The IMI did purchase those items with help from Peabody Coal; we appreciate that. We encourage people to support the raffle.

I will turn the session over to Mark Cavinder, Vice President and General Manager of Old Ben Coal Company who will start our first technical session entitled "Advances in Coal Cleaning and Mine Operations." Mark.

TECHNICAL SESSION I
Advances in Coal Cleaning and Mine Operations

Thursday, September 24, 1998
Mississippian Room, Gateway Center

Mark Cavinder: Thank you, Gregg. We have four papers this morning. We are more heavily weighted toward surface mining and coal preparation today and a little bit more weighted toward underground mining tomorrow. The first paper is going to be presented by Rick Honaker. It has to do with what I call getting the "squeal out of the pig" in preparation. It is all those ways to maximize recovery in the prep plant and still satisfy the customer.

Mark Cavinder opens first technical session.

Rick Honaker is an associate professor at Southern Illinois University at Carbondale. He has bachelor and master of science degrees and a Ph.D. in mining engineering from Virginia Tech. He joined the SIU faculty in 1991 and has worked around coal minerals and processing. He has over fifty publications related to coal preparation, and he is very knowledgeable. So, I would like to ask Rick to come forth and present his paper, and I thank him very much for being here today.

Rick Honaker: Well, thank you very much. I am excited to be here. In fact, I would like to thank you for inviting me to come and give this talk. This talk is sort of a summary of several years of research that we have done at SIU where we have investigated several different new ways to clean fine coal.

IMPROVED PROFITABILITY USING ADVANCED FINE COAL PROCESSING FOR ILLINOIS COAL MINES

R. Q. HONAKER, A. PATWARDHAN AND H. SEVIM

Southern Illinois University at Carbondale
Carbondale, Illinois

ABSTRACT

A coal preparation plant model has been developed and used to determine the techno-economic benefits that can be realized from the application of advanced fine coal cleaning (AFCC) technologies and overall plant optimization. The optimization procedure reveals that the benefits of AFCC technologies are more pronounced for more stringent product quality constraints while simple optimization of the existing plant is sufficient for more relaxed constraints. The idea of optimization and the use of AFCC technologies for improving mine profitability was demonstrated for a mine producing three million tons of Illinois coal from the Herrin (Illinois No. 6) seam. Optimization of the existing plant operation has the potential of generating an additional plant yield of 1.0 percent at the same product quality constraint. This yield improvement corresponds to an additional income of $0.59 million/year. Application of AFCC technologies like column flotation and enhanced gravity concentrators can provide a 3.25 percent improvement in the plant yield corresponding to an incremental net income of $1.57 million/year.

INTRODUCTION

Traditionally, the coal preparation plant flowsheet integrates three or four cleaning circuits which are commonly referred to as coarse (+1/4 inch), intermediate (1/4 inch x 28 mesh) and fine (minus 28 mesh) coal circuits. Typically, the operating conditions (i.e., gravity cut-points for gravity-based separation devices and residence time for flotation devices) of each circuit are adjusted to produce nearly equal quality products, as defined by the coal contract. The problem associated with this traditional approach of coal preparation is that, in spite of the better liberation characteristics (superior cleanability potential), the required product qualities cannot be achieved from the conventional fine coal cleaning circuits due to their inefficiency in producing clean products at high mass yields. Consequently, better product qualities have to be realized from the less liberated coarse circuits. Thus, maintaining a lower gravity cut-point (d_{50}) in the coarse circuit is a common plant practice to achieve the required product quality. However, the low d_{50} values in the coarse coal circuit negatively affect the overall plant yield since the majority of the run-of-mine coal is treated in this circuit (typically about 50 percent).

Ideally, the plant clean coal yield can be maximized by producing a cleaner product from the well-liberated fine size fraction without a significant loss in the circuit yield, while producing a slightly dirtier product from the more massive coarse coal circuit at a higher yield. This ideal approach cannot be employed using conventional fine coal cleaning technologies due to their inherent inefficiencies. The development of advanced fine coal cleaning technologies allows the production of high quality fine coal concentrates while achieving high energy recovery values. Thus, using these technologies, a coal operator may be able to blend the high quality material from the fine circuit with the coarse material to achieve the required product quality at an improved overall plant yield.

Comparative Example of Conventional and Optimized Plant Operation Approach

The possible improvements in the overall mass yield can be demonstrated by a hypothetical plant in which the mass distribution of the run-of-mine feed results in 50 percent, 30 percent, and 20 percent of the material reporting to the coarse, intermediate and fine coal circuits, respectively. A typical set of yield-grade curves is shown in figure 1 which represent the theoretically ultimate curves obtained from washability analysis.

Conventionally, plant operators try to meet the ash content specified in the contracts by producing equal ash products from all the plant circuits as shown in figure 1. Thus, in this example, the production of a 10 percent ash requirement results in mass yields of 48 percent, 68 percent and 83 percent from the coarse, intermediate, and fine coal circuits, respectively, providing an overall mass yield of 61 percent. However, as shown in figure 2, the overall mass yield can be improved by 5.8 percent by merely optimizing the existing integrated circuit operation. The optimized circuit utilizes the greater cleaning potential of the fine fraction to allow the use of higher gravity cut-points in the coarse and intermediate circuits. The improvement of 5.8 percent mass yield units is realized by producing 8.5 percent, 9 percent and 11 percent ash products from the fine, intermediate and coarse circuits at corresponding mass yields of 80 percent, 66 percent and 62 percent. The above improvement may be further enhanced when highly efficient AFCC technologies operating at low gravity cut points are utilized.

Complexity of Optimization Problem

There are numerous possible operation settings that can improve overall plant yield. The selection of the best setting from these possible settings is necessary to obtain the ultimate yield from the plant. The determination of such a setting is complicated as it is a function of the material in each size fraction and the equipment used. For example, when reducing a fraction of ash in a three-product plant, the changes required to maximize

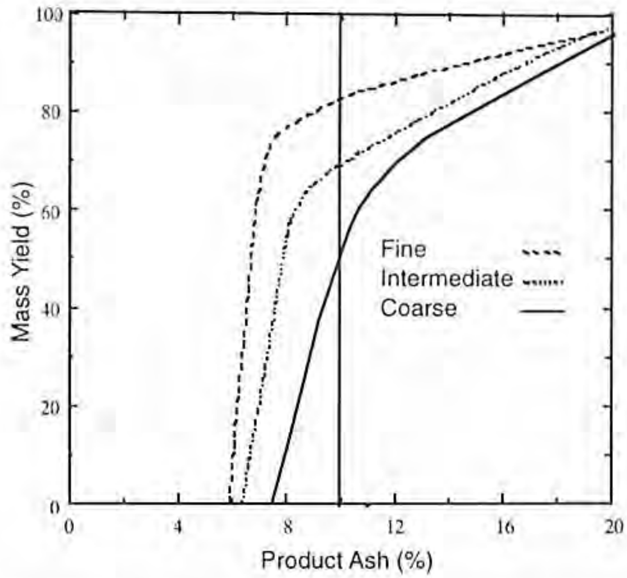


Figure 1. Typical yield-grade curves for a three-circuit coal preparation plant using conventional cleaning circuits producing equal grade products from the individual circuits.

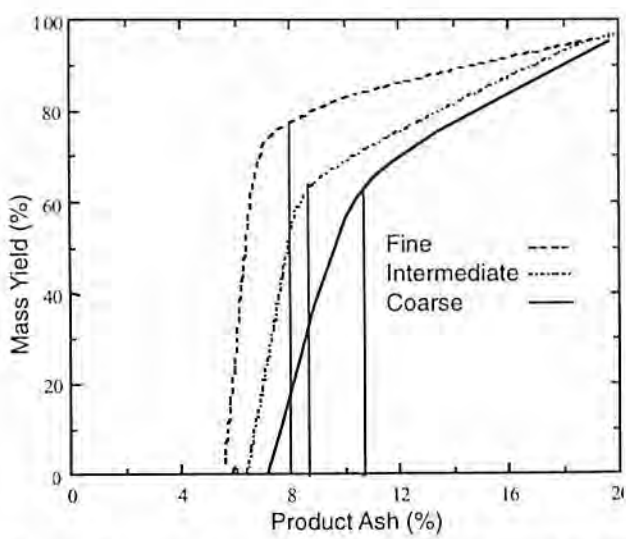


Figure 2. Required separation performances from each circuit to achieve maximum plant mass yield.

plant energy recovery would be a function of the coal liberation characteristics in each fraction, the size-by-size efficiency provided by each process unit, and the d_{50} cut-point. Since the efficiency of a unit (E_p) is a function of both particle size and separation density (d_{50}), the problem of plant optimization becomes even more complex.

Necessary Condition for Optimization: Equalization of Incremental Ash

The optimization problem is to determine the d_{50} cut-points of each circuit so as to maximize the overall yield at the desired ash content. The solution to this problem is achieved by equalization of incremental ash of all the plant product streams. The incremental ash of a float product is defined as the ash content of the dirtiest particle within it. This condition of equal incremental ash from all the plant product streams ensures that the dirtiest particle recovered from any circuit is the same. This approach is reasonable since rejecting a cleaner particle from the fine circuit while recovering a dirtier particle from the coarse circuit will not result in an optimal plant operation (Salama, 1991).

ADVANCED FINE COAL CLEANING

To achieve the plant operating conditions suggested by optimization, the use of highly efficient separation technologies may be required, especially for the finest particle size fractions. Several advanced fine coal cleaning technologies, such as hindered bed separators, enhanced gravity concentrators and column flotation, have been developed during the past two decades. Many of these advanced technologies, which provide highly efficient separations over a range of product grades, have been tested side-by-side with existing conventional technologies and have been found to be very effective. The superior performance is a result of the elimination of non-selective mechanisms, application of enhanced gravity forces, and superior middling handling abilities of the advanced cleaning devices. If these advanced fine coal cleaning technologies can be properly integrated into the coal preparation plant flowsheet, mass yield can be maximized in the fine coal circuit while producing a high quality product. This will allow the coarse coal circuit to be operated at a higher d_{50} value to maximize the overall plant yield.

SIMULATION AND MODEL DEVELOPMENT

Plant Simulation and Circuit Optimization

The authors have developed a model that can simulate the preparation plant performance. The optimization methodology based on the concept of incremental ash equalization was formulated and incorporated in a model to predict the maximum achievable plant yield, satisfying single or multiple product quality constraints. The details of this model are published elsewhere (Patwardhan, 1998).

Once the optimum plant yield has been determined, the data is fed into an economic evaluation model developed by the authors to investigate the economic benefits of circuit optimization and installation of AFCC systems (Patwardhan, 1998).

Economic Evaluation

Using the overall plant yield values of the optimized plant and the advanced circuit plant obtained from computer simulations, a detailed economic analysis was conducted in two phases. The incremental cost of producing clean coal is calculated in the first phase, whereas the incremental annual income for the optimized plant and advanced circuits is estimated in the second phase. The calculations were performed using an EXCEL spreadsheet model. A simplified flowchart explaining the major steps involved in economic analysis is shown in figure 3. The necessary engineering and cost information to estimate the incremental cost of producing clean coal in the optimized conventional plant and advanced circuits were obtained from the coal companies, plant designers and equipment manufacturers, handbooks and other published data (Anon., 1987; Gentry and O'Neil, 1984; Mular, 1978, and Leonard, 1991). The model provides the option of considering replacing a conventional fine coal cleaning circuit with an AFCC system or installing a new AFCC system. The differential capital cost was annualized based on a useful life of ten years and a minimum required rate of return of 12 percent.

RESULTS AND DISCUSSION

Plant Circuit

The plant optimization and evaluation of techno-economic benefits of advanced fine coal cleaning technologies have been conducted for a preparation plant using coal from the Herrin (Illinois No. 6) seam. In this preparation plant, the 1/4 inch feed coal is treated by a primary heavy media vessel, while the 1/4 inch x 4 mesh material is cleaned in a fine heavy media vessel. The tailings from both the coarse and fine heavy media vessels are then combined and retreated in a secondary heavy media vessel. The floated material from each of the heavy media vessels is combined as a final +4 mesh product. The 4 x 28 mesh particle size fraction is treated in Dynawhirlpools (DWP), which are special types of heavy media centrifugal separators. The Dynawhirlpools are used in a rougher-scavenger circuit arrangement. The -28 mesh size fraction is treated in conventional flotation cells in a rougher-cleaner circuit arrangement. The preparation plant treats a run-of-mine feed ash of 27.4 percent and produces an overall mass yield of 72.31 percent with a product ash content of 7.44 percent.

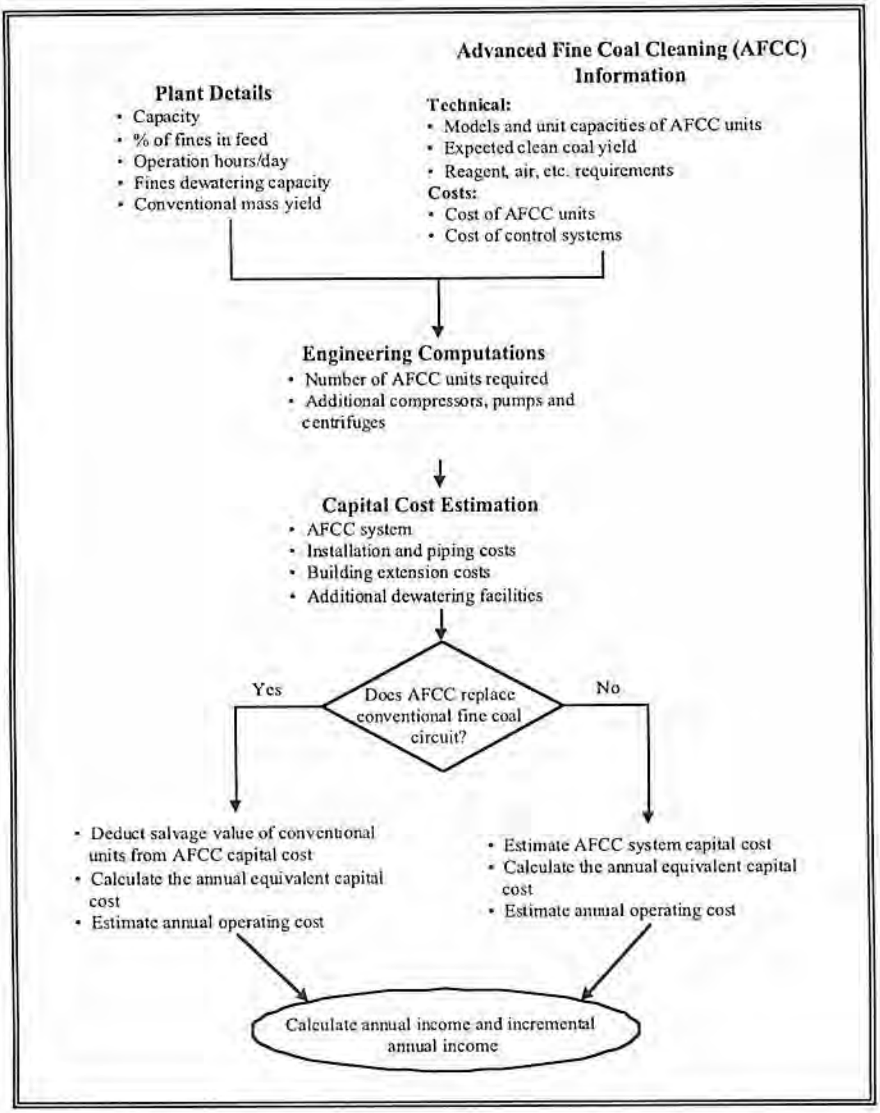


Figure 3. Simplified flowchart of economic analysis model to evaluate the economic benefits of plant optimization and advanced fine coal cleaning circuits.

Metallurgical Performance Improvement

The plant evaluated in this study treats approximately three million tons of run-of-mine coal per year. Using the metallurgical performance data obtained from the operating plant and the aforementioned plant optimization model, the plant performance was optimized for different product ash constraints. As shown in figures 4 (a) and (b), at the current target product ash level of 7.44 percent, plant optimization with the existing conventional circuits predicted a 1.0 percent increase in the overall clean coal yield.

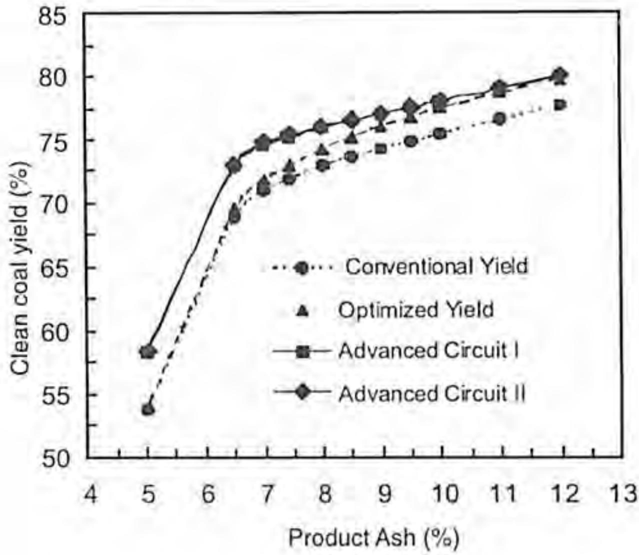
Two advanced fine coal cleaning systems were evaluated. Advanced I system consists of column flotation. The Advanced II system consists of an rougher-enhanced gravity concentrator as a primary cleaning unit, followed by a flotation column in a rougher-cleaner arrangement. Replacement of the conventional flotation cells with the Advanced I configuration in this plant would result in an additional 2.22 percent improvement in clean coal yield. Advanced II configuration, however, would only provide a marginal increase in yield by 0.2 percent over that of the Advanced I circuit. These findings are the result of superior ash cleaning achieved by column flotation for the fine coal in this study, which contains a relatively low amount of mixed-phase and pyrite particles. In another study covered by the authors, similar analyses have shown that enhanced gravity concentrators provide significant yield improvements for coals containing moderate to large amounts of mixed phase and coal pyrite particles.

It may also be noted that, at lower target product ash levels, the advanced fine coal cleaning circuits show a significant increase in clean coal yield. For example, at a product ash content of 5.0 percent, the Advanced I circuit would provide 4.41 percent higher yield over the optimized plant with the existing circuits. It is also noted that the plant optimization does not significantly increase the mass yield at lower product ash levels. This trend is a result of the limitations with the conventional cleaning technologies utilized in the fine coal circuits. The conventional flotation cells do not efficiently treat the clay mineral particles and the middling particles, which is necessary to achieve low ash products from the fine coal circuits. On the other hand, flotation columns operated with a deep froth zone provide more selective flotation environment, and, hence, there exists a large difference in clean coal yield between the optimized plant with existing units and advanced circuits at lower product ash levels as shown in figures 4 (a) and (b).

Translation of Metallurgical Improvements to Economic Benefits

The metallurgical benefits presented above are expressed in terms of incremental economic benefits using the developed economic model. This analysis considered the base level mining and processing costs of $10 and $3 per ton of raw coal, respectively, and a selling price of $20 per ton of clean coal. The overall plant yield was 72.32 percent at a product ash content of 7.44 percent. Figures 5 (a) and (b) exhibit the economic benefits achievable over a range of target product ash values. As seen, an optimized plant with the existing cleaning technologies would increase the annual income by about $0.59 million, while achieving the current target grade. The advanced circuits I and II would increase the annual income by another \$0.98 million and \$0.85 million, respectively, over and above the increase achievable by simple optimization of the existing circuit. Thus, a total increase in income of \$1.57 million and \$1.44 million can be expected due to the installation of advanced circuits I and II, respectively. The increase in income is a net increase after the deduction of the incremental annual operating costs and the annualized capital costs applied towards the installation of the new units.

(a)



(b)

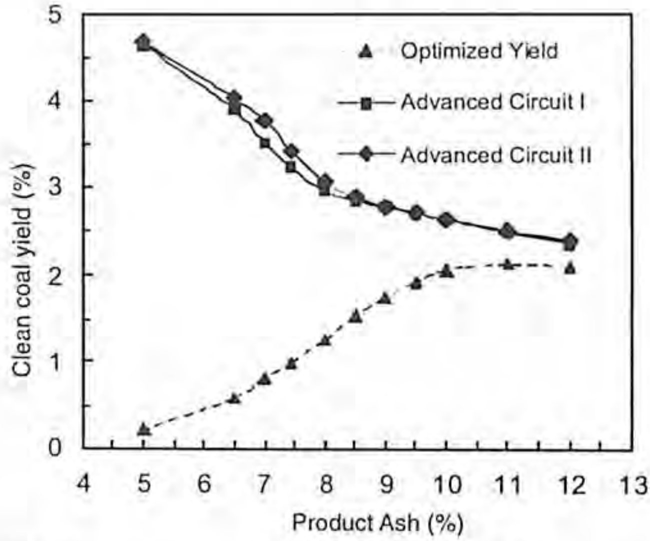


Figure 4. Predicted improvements in clean coal (a) yield and (b) incremental yield on the basis of product ash content for the optimized plant with the existing cleaning circuits and the advanced cleaning circuits for the treatment of coal from the Herrin (Illinois No. 6) seam.

It can be seen here that although the advanced circuit II provides a marginal increase in yield over advanced circuit I, the increase in income associated with the application of advanced circuit II is lower than that for advanced circuit I. This is because the additional capital expenditure for advanced circuit II is not justified for the improvement in yield it offers. Also, the optimization of the conventional circuit provides a very marginal benefit for stringent product quality constraints where the application of the advanced fine coal cleaning circuits becomes imperative because of reasons indicated earlier. On the contrary, for more relaxed product quality constraints, optimization of the conventional circuit itself provides a significant increase in income, while the addition of the advanced circuits just pays for its capital investment at the required minimum rate of return.

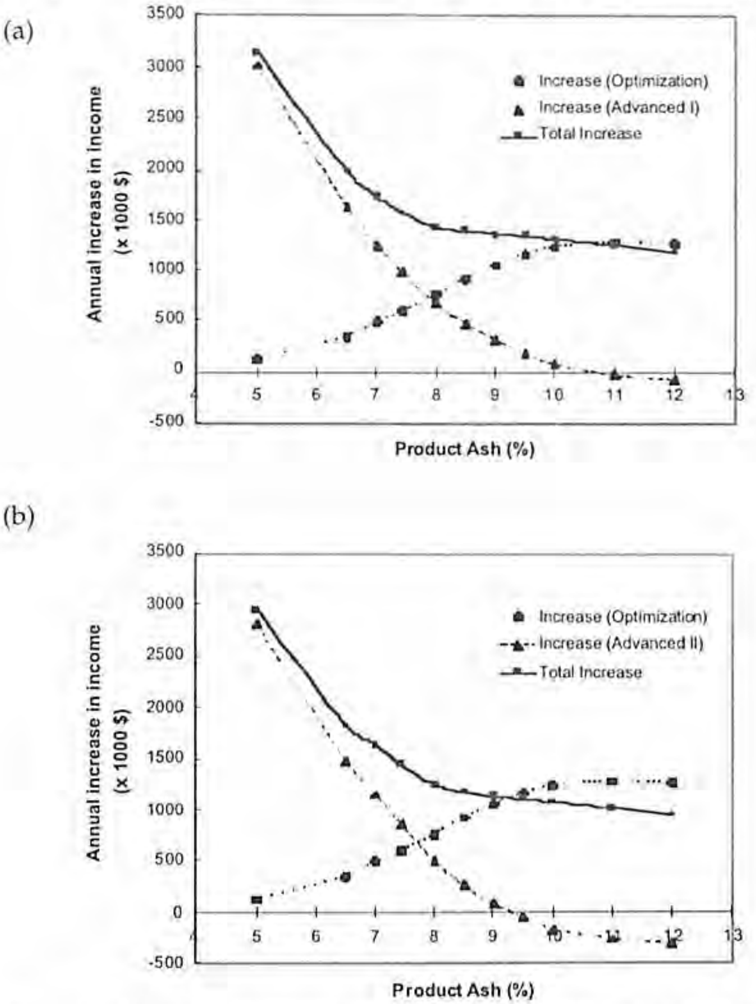


Figure 5. Predicted (a) annual income and (b) increase in annual income for the optimized plant with the existing cleaning circuits and the advanced cleaning circuits for the treatment of coal from the Herrin (Illinois No. 6) seam.

CONCLUSIONS

- A significant improvement in mine profitability was predicted from the improved plant clean coal yield values resulting from the replacement of conventional fine coal cleaning technologies with advanced technologies. An increase in annual income by $1.57 million was predicted for the replacement of the conventional flotation with column flotation. This finding was obtained based on the current product ash requirement of an Illinois preparation plant treating coal from the Herrin (Illinois No. 6) seam.

- Optimization of the existing conventional coal cleaning circuits using a constant incremental product quality approach predicted a substantial improvement in overall plant clean coal yield. The increase in incremental yield obtained, while ensuring the current product quality requirements, was 1.0 percent. This improvement could be easily realized without additional capital.

- For the coal preparation plant evaluated in this study, the greatest clean coal yield improvement was obtained from the flotation column based circuits. When considering product ash content as a sole constraint, the replacement of the conventional flotation cells with flotation columns provided a 3.25 percent increase in the overall plant mass yield.

- The plant simulation results indicate that more stringent product quality requirements will necessitate a more efficient fine coal cleaning system to maintain profitability.

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RECENT ADVANCEMENT OF FINE COAL DEWATERING USING A BRIQUETTING MACHINE FOR ILLINOIS BASIN COAL

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ABSTRACT

The high sulfur content of the coal in the Illinois Basin has been a significant factor in the downturn of the coal industry in the state of Illinois. Many of the coal-burning utility plants in the midwest, including Illinois, Missouri, Kansas, Iowa and Oklahoma, historically burned Illinois coal. However, as the new environmental regulations regarding sulfur emissions have been implemented, several of these plants have switched, or partially switched, to burning low sulfur western coal from Wyoming. To regain the steam coal market and make the Illinois coal mining industry more viable and competitive, it is essential that low sulfur and ash Illinois coal with acceptable transportation costs, storage and handling characteristics must be produced.

The research work described here focuses on the dewatering and reconstitution of deep cleaned coal fines using commercially available briquetting machines. With the help of a bitumen emulsion that serves as a dewatering and bonding agent, results in both laboratory and pilot-scale experiments have demonstrated that fine coal dewatering and briquetting can be combined in a single-stage process using a roll briquetting machine.

INTRODUCTION

The high sulfur content of the coal in the Illinois Basin has been a significant factor that has affected the coal industry of the state of Illinois. Many of the coal-burning utility plants located in several midwestern states, including Illinois, Missouri, Kansas, Iowa and Oklahoma, historically burned Illinois coal. However, several have switched or partially switched to western low sulfur coal which is shipped from Wyoming. Semin and Unal (1998) reported that the sales of Illinois coal for utility uses have dropped from 54 million short tons (st) in 1990 to 41 million st in 1995. It is also projected that the downward trend will reach 37.5 million st by the year 2000 when Phase II of the Clean Air Act is implemented. As a result of this fuel switching at some midwestern utility plants, a large number of coal mines have been shut down due to the high sulfur content of the Illinois coal. In order to regain the steam coal market and make the Illinois coal mining industry more viable and competitive, low sulfur and ash Illinois coal with acceptable transportation, storage and handling characteristics must be produced to meet the environmental and gas emission limitations recently enacted.

Coal cleaning research conducted at Southern Illinois University-Carbondale has shown that deep cleaned low sulfur and ash Illinois coal can be produced using a combination of column flotation and gravitational separators. In the development of this deep cleaning process, a large proportion of fine coal particles are produced by the grinding and pulverizing processes in order to liberate the finely disseminated mineral and pyrite particles. After the cleaning process, the fine coal product entraps a large amount of water and makes the dewatering of the filter cake much more difficult than moderately ground coal particles. Moreover, this fine coal creates dust control problems during its transportation and results in storage and handling difficulties at coal burning plants.

In order to overcome the above-mentioned problems and to fully utilize this technology, an efficient dewatering and re-constituting process of fine coal must be developed at the downstream end of the deep cleaning process. This product must have a low moisture content and high strength, be transportable and, overall, economical to produce. This paper summarizes the research effort of the Mining Engineering Department at the University of Missouri-Rolla regarding the development of a single stage fine coal dewatering and briquetting process.

SINGLE STAGE FINE COAL DEWATERING AND BRIQUETTING PROCESS

Dewatering and Briquetting Reagent. In the development of this novel dewatering process, bitumen emulsion was used exclusively as the dewatering and binding agent. The bitumen emulsions are made by dispersing the bitumen material into the liquid phase, usually water, with the help of interfacial reagents in a high shear-mixing mill. More specifically, these emulsions can be seen as bitumen-water mixtures composed of tiny submicron size bitumen droplets suspended in water.

Dewatering and Briquetting Mechanism of Bitumen Emulsions. When the bitumen emulsion is mixed with the fine coal samples, the bitumen droplets are evenly dispersed throughout the coal sample, due to its water-based characteristics. The moisture content of the coal-bitumen mixtures in this research could be as high as 55 percent for the briquetting process. Because of the hydrophobic nature of the bitumen materials and their chemical affinity to coal particle surfaces, the dispersed bitumen droplets can easily be adsorbed onto the coal particles. Consequently, the hydrophobic coal surface isolates water from itself during the mixing process (fig. 1). After thorough mixing, the bitumen-coated mixtures are ready to be fed into a roll briquetting machine to be reconstituted into coal briquettes.

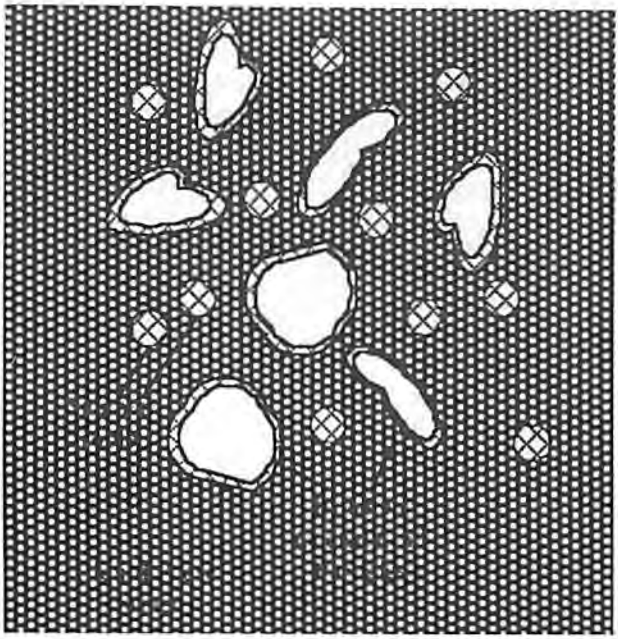

Figure 1. Adsorption of bitumen on a coal particle surface.

Briquetting Process and Dewatering Mechanism. In this research, commercially available laboratory and pilot-scale roll-type briquetting machines were used. The coal-binder mixture was then fed into a roll-type briquetting machine by a horizontal screw, where the sample was compacted between two rolls within the confines of the pockets on the rolls within the briquetting machine.

During the briquetting process, the coal-binder mixture undergoes two stages of dewatering. In the feeding stage, the horizontal screw feeder pushes the feed material into the roll press. Because of the difference between roll and feed screw speeds, the coal-binder mixture tends to accumulate in front of the briquetting rolls. Due to the feed-screw extrusion effect, water is expelled from the feed at the pre-densification zone prior to the compaction stage. At the second stage of dewatering, the coal-binder mixture is compacted between the two rolls that rotate against each other under high pressure. Most of the remaining water is then squeezed out of the mixture as the briquette is formed; this is the roll compaction and briquetting effect.

Briquetting Machines. Funded by the Illinois Clean Coal Institute, both laboratory and pilot-scale studies on dewatering and briquetting of fine coal had been carried out at the Department of Mining Engineering at the University of Missouri-Rolla. K. R. Komarek briquetting machines, models B100 and B220, were employed in laboratory and pilot-scale studies, respectively. The briquetting rolls of the Model B100 laboratory-scale briquetting machine were 2.0 inches wide and 5.1 inches in diameter. The briquettes produced were of a pillow shape and measured 1.5 inches long, 0.75 inch wide and 0.625 inch thick. The briquetting machine has an approximate capacity of 100 lbs/hour. Operating variables, such as roll speed, feed screw speed and roll separating forces, can be adjusted to vary the dewatering efficiency.

Similar to model B100, Komarek model B220, which has a capacity of 1.5 tons/hour, was used for the pilot-scale briquetting machine tests. This machine is equipped with two rolls that are three inches wide, 12 inches in diameter and consist of 24 pockets. Each pocket produces a pillow-shaped briquette that measures approximately 1" x 1.5" x 2.5".

LABORATORY SCALE BRIQUETTING RESEARCH

In the laboratory-scale experiments, the objectives were to determine the efficiency of bitumen emulsion as a dewatering aide and the preliminary dewatering characteristics of the briquetting process. Two types of Illinois Basin coal were used in the laboratory-scale study, namely, IBC-108 (a blend of Herrin and Springfield coal), and Springfield (Illinois No. 5) coal. The samples were provided by the Illinois State Geological Survey and Turris Coal Mine, Elkhart, IL. The test results are summarized below.

Influence of Compaction Pressure on Moisture Reduction of Fine Coal. The average moisture content of the IBC-108 filtered product (-400 mesh) was 43.8 percent, as received basis. After mixing the coal sample with the bitumen emulsions, the moisture content of the coal-binder mixture was 52 percent. As seen in figure 2, moisture reduction of the coal-binder mixture increased as the compaction pressure increased. The increasing pressures were able to "squeeze" more water out of the coal sample. Furthermore, the coal briquettes produced using the bitumen emulsion have a lower moisture content at each compaction pressure tested than those without the addition of the bitumen emulsion. The effectiveness of bitumen emulsion as a dewatering aide is clearly shown in figure 2.

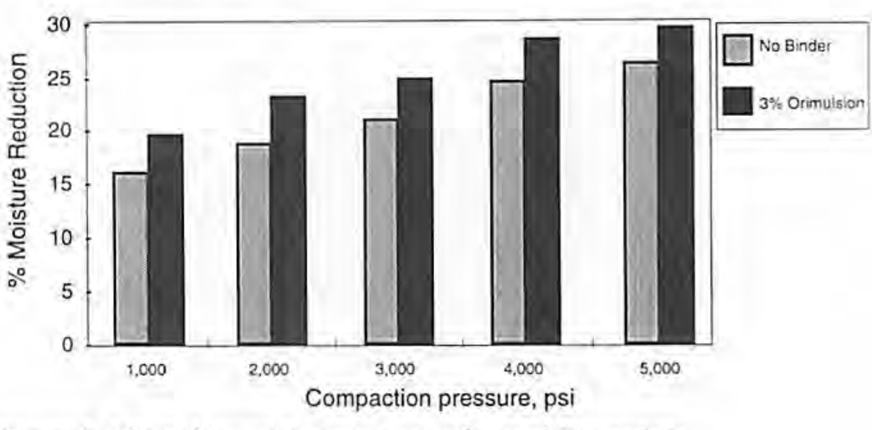

Figure 2. Effect of compaction pressure on fine coal dewatering.

Water Absorption Tests. Besides the low moisture content and robustness of the coal pellets made with the help of the bitumen emulsion, the coal pellets also possess high water resistance. The water absorption tests were conducted by submerging the coal pellets in water for 24 hours after being manufactured. The amount of moisture gained was used as a measure of evaluating the water resistance of the coal pellets. Three types of bitumen emulsions, namely Orimulsion, SS-1H (anionic slow set bitumen emulsion) and PC-150 (asphalt emulsion) were used in this study. All the briquettes were made under the same compaction pressure (5,000 psi) and three weight percent of binder. Figure 3 shows the water resistance of the pellets using different types of bitumen emulsion. The results indicate that the coal pellets made with bitumen emulsion absorbed significantly less water than the coal pellets made without the addition of any binder (23.9 percent to 27.5 percent less).

PILOT-SCALE SINGLE STAGE DEWATERING AND BRIQUETTING RESEARCH

The promising results obtained from the laboratory-scale study suggested that a pilot-scale investigation on the application of a single stage dewatering and briquetting process on fine coal was warranted. In the pilot-scale study, Springfield (Illinois No. 5) coal (-400 mesh) from the Galatia Mine was used to produce coal briquettes using a modified pilot-scale briquetting machine.

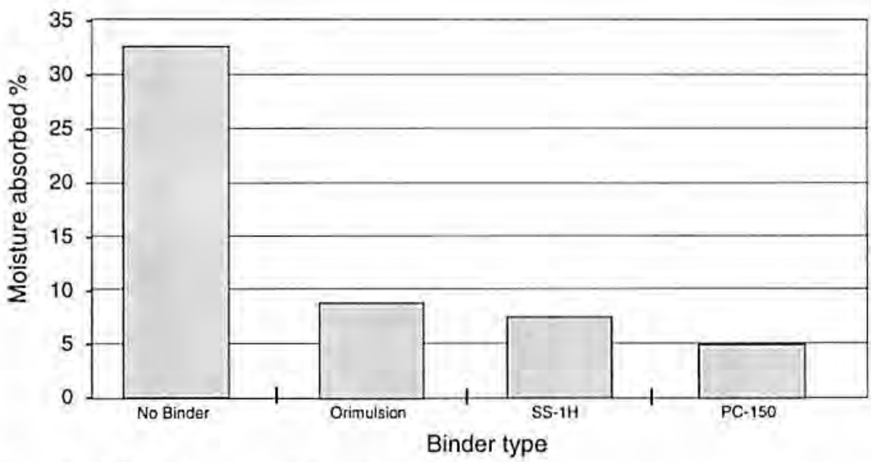

Figure 3. Water absorption of coal briquettes.

Effect of Curing Time on the Moisture Content of Briquettes. Figure 4 demonstrates that as the curing time increases, the moisture content of the briquettes is reduced continuously. After 24 hours of curing at room temperature, the average moisture content dropped from 35 percent to 28 percent. Most of the water that remained in the briquettes evaporated from their surfaces more easily because of the hydrophobic nature of the coal-binder mixture. Therefore, the moisture content of the briquettes was reduced dramatically with the passage of time.

The hydrophobic nature of the coal-binder mixture was further demonstrated by the results from the water absorption tests (fig. 4). Although the net amount of water re-absorbed during the tests increased with increasing curing time, the actual moisture content never exceeded the initial level of the freshly produced briquettes. The moisture content continued to decrease and eventually dropped to an average of 21 percent after a 24-hour re-curing period. More importantly, after 72 hours, the total moisture content was reduced to an average of two percent. This further substantiates the findings that the hydrophobic nature of the coal-binder mixture continued to evaporate the water from the briquettes.

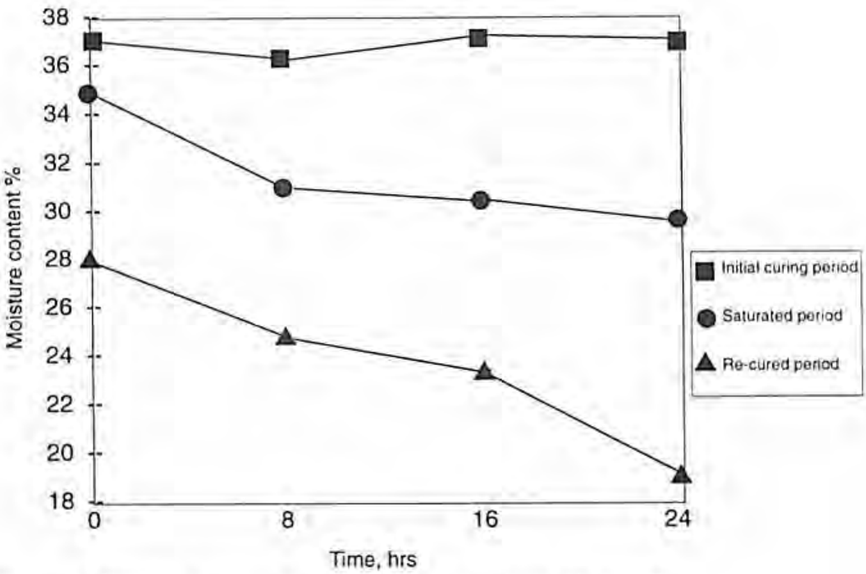

Figure 4. Effects of curing time on moisture content of briquettes.

Effect of Curing Time on the Friability of Briquettes. In order to evaluate the friability of the briquettes, an ASTM drop test (ASTM Standard D440) was conducted. The friability of the briquettes decreased with increasing curing time (fig. 5). However, the friability of the product did not change after 16 hours of curing. This may be attributed to the fact that the presence of water inhibited the binding effect of the coal-binder mixture. After 16 hours of curing, the moisture content was substantially lowered and allowed the binding effect of Orimulsion to manifest itself, thus increasing the friability of the briquettes.

Effects of Binder Concentration on Briquette Characteristics. Figure 6 shows the results of the briquettes after 24 hours of curing when the binder concentration was tested at five and seven percent, respectively There was no significant difference in the cured and saturated moisture between the experiments, indicating that the moisture content of the briquettes was insensitive to this range of binder concentration. On the other hand, it can be observed from figure 5 that there was a significant effect on the friability of the briquettes. The higher the binder concentration, the stronger the briquettes. This is a result of full coating of the coal particles with the binder-solvent mixture and better binding between the coal particles.

Effect of Roll Speed on Briquette Characteristics. Test results suggest that roll speed has a significant effect on the friability of the briquettes (fig. 5). The results of the drop test indicated that the friability of the briquettes was reduced with increasing roll speed. The reduced residence time at high roll speed contributes to less compaction during briquetting, thus reducing the friability of the briquettes.

It was also found that the moisture content of the briquettes was insensitive to the roll speed at a binder concentration of seven percent. Under the studied experimental conditions, it appears that the mechanical dewatering might reach its threshold when no more water can be rejected from the coal-binder mixture as a result of compaction. However, further moisture reduction can take place through evaporation of the water from the briquette surface.

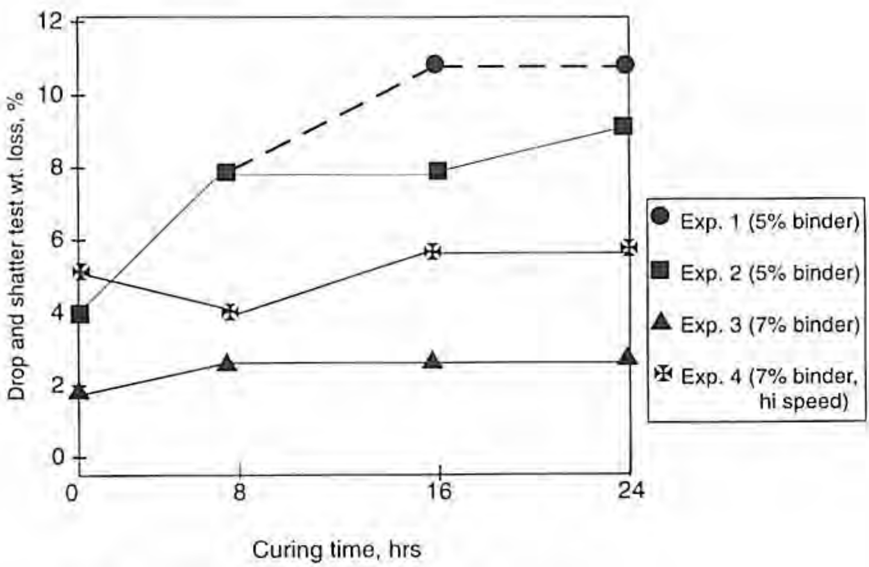

Figure 5. Effects of curing time on the strength of briquettes.

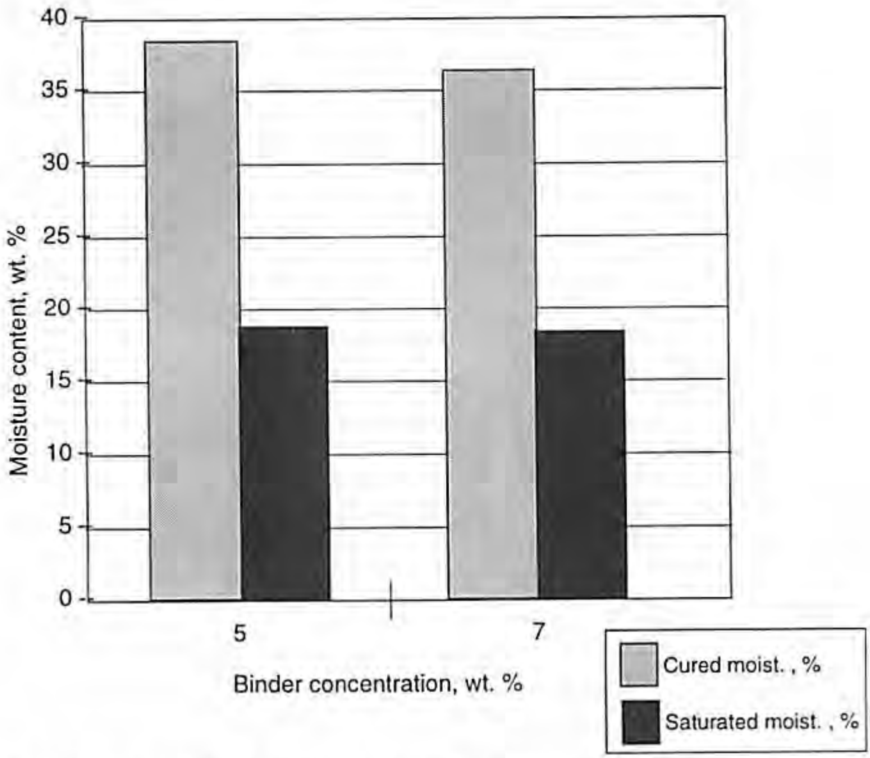

Figure 6. Effects of binder concentration on briquette moisture content.

CONCLUSIONS

Results from this work demonstrated that transportable fine coal briquettes with low moisture content and high strength can be produced using commercially available briquetting machines. Variables such as binder type, binder concentration, curing and compaction time, have significant effects on the characteristics of the final product. By integrating the deep coal cleaning and dewatering and briquetting processes into a continuous circuit at a coal preparation plant, a low sulfur and low ash clean coal product with acceptable storage and handling characteristics can be produced for utility plants. With deep cleaned Illinois coal, it will be possible to comply with environmental and gas emission regulations, and many of those utility plants that switched to western coal may be able to return to Illinois coal because of its high heating value and low moisture content when compared to western coal. Consequently, the mining industry of the state of Illinois may still be able to recapture markets and be more competitive in the overall national coal market.

John Wilson: I would like to add one or two things to our paper and Steve's presentation. Steve works with me, and I have been involved in this for over three years. The reason for this research is that the coal industry throws away tens of millions of tons of coal in the form of fines. There are a lot of Btus in those fines. In fact, there are a lot of companies trying to recover these old tailings fines, especially where the old piles occur next to power plants because transportation costs are virtually zero. We at UMR became involved with the Illinois Clean Coal Institute and an 'add on' to Rick Honaker's deep coal cleaning work. His work benefits the industry by producing better quality coal in terms of sulfur reduction. But the deep cleaning process produces more coal fines, which are difficult to dry and recover; so this is how we became associated with ICCI. Since Steve has been my graduate student, we've been working with two companies, one in Pennsylvania that is trying to recover a high-grade coal with 25 percent moisture; I might add, this is a lot easier to briquette than the coal fines resulting from the deep cleaned coal, which was 44 percent moisture. Our work has demonstrated that we are able to successfully make briquettes from the wet fine coal.

The main purpose in briquetting coal fines is so we can transport the coal fines and not have to discard this valuable source of Btus. If briquettes break into a few pieces, this is not a serious problem, just so long as they don't return to fine coal particles again. It is required to make the briquettes strong enough to get from A to B and also reduce the moisture by using the hydrophobic binder. The coal fines from Illinois that we have been working with have a heating value in the range of 11,000 to 12,000 Btu/lb.; there are over two million tons of it generated each year. Our research effort seeks practical ways and opportunities to make a few bucks for the mining companies. Thank you.

Mark Cavinder: Thank you, Steve. The next paper we have is "Applying Variable Frequency Conveyor Drives at the Galatia Mine." It is going to be presented by Tom Denton , with some help by Bob Conn.

Tom Denton is the Chief Engineer at The American Coal Company's Galatia Mine in Harrisburg. He has a B.S. degree in mining engineering from Virginia Polytechnic Institute and State University and an M.B.A. from Southern Illinois University at Edwardsville. He has over eighteen years of engineering and operating experience in the coal industry and is a licensed professional engineer. I know Tom personally; he is very knowledgeable, and I look forward to listening to his paper. I can remember 20 years ago, when we started longwalling, we were putting in belt lines 2,000 feet long on panels; we all knew that it was going to get to be two, three, four miles long in time, and it's here. So, Tom is going to tell us how it works.

Tom Denton: Thank you, Mark. It is a pleasure for me to be here today. Before I get started, I want to first introduce Bob Conn. Bob is the electrical instrumentation foreman for The American Coal Company. He is intimately familiar with all of the 30 or so conveyors at the mine that are monitored and controlled using programmable logic controllers.

You don't have to be an electrical engineer to understand what we will be talking about today. I will be discussing the general operation of these variable frequency drives (VFDs) and then give some examples of how we put them to use underground.

I can remember about 12 years ago (Mark, you might remember this), when back at Old Ben, a vendor came to the maintenance manager's office. He had a tiny motor that was connected to a little box. The box was a variable frequency drive, and I was intrigued with how the vendor could change the frequency of the field windings in the motor and change the speed of the motor. I immediately thought of conveyors for a great application of this new technology. Unfortunately, at that time, 30 horsepower was the largest variable frequency drive available. With the advances in electronics and increases in horsepower capabilities of variable frequency drives since then, we are finally able to put them to practical use. Today, you will learn how this happened at the Galatia Mine.

APPLYING VARIABLE FREQUENCY CONVEYOR DRIVES AT THE GALATIA MINE

THOMAS DENTON AND ROBERT CONN
The American Coal Company
Harrisburg, Illinois

Thomas Denton

Robert Conn

INTRODUCTION

For years, longwall panel conveyors at the Galatia Mine have been driven by dual 250 horsepower motors with fixed-fill fluid coupling transmissions that provide a 15 to 20 second starting time. These drives are very economical and work well for shorter panels requiring conveyor horsepowers of 500 or less. However, the Galatia Mine, like other longwall mines, is mining longer and longer panels. The 1st West Panel in the Galatia North reserve requires a conveyor approximately 13,000 feet in length and has a vertical lift of 50 feet. The existing 500 HP drives do not have enough horsepower or the proper starting characteristics for a conveyor this long.

DESIGNING A CONVEYOR DRIVE SYSTEM AT GALATIA MINE

A team of operations, engineering and maintenance personnel went to work designing a conveyor system for these long panel belts. The two options considered for long panels were: 1) breaking the panel into two separate 500 horsepower conveyors, and 2) a single long conveyor with a 500 horsepower main drive and a 500 horsepower intermediate booster or tripper drive. Each has some advantages and disadvantages.

The two flight conveyor option has the advantages of being simpler, less risky, and it can utilize existing drives. The disadvantages include the potential additional production delays from another conveyor and transfer point in the system. Also, a second belt storage unit would be needed, or extended longwall idle time to move the second conveyor's storage unit to the first conveyor. Another disadvantage is the long area of extra height excavation required by the second drive, since excavation must be made for the transfer, drive and storage unit. This extra height in the longwall headgate can cause production problems for the longwall when retreating through the area.

The option of using a single conveyor with an intermediate tripper drive has some distinct advantages. First, only a single belt storage unit is installed at the first drive avoiding the cost for a second unit or the longwall production loss to move one. Second, the extra height excavated area is shorter since it only must cover the area of the drive itself, not a takeup or belt storage unit. Fewer production problems associated with the longwall retreating through this area can be expected. Also, the amount of time that the longwall is idle to remove the tripper drive is shorter than if a second conveyor and storage unit is used. In addition, one less conveyor increases the overall availability of the conveyor system. A drawback of the tripper option is that it requires a more sophisticated drive system, one that can provide long gradual starting of the conveyor and can accurately control the load-sharing between the main drive and the tripper drive. The Galatia Mine's existing fixed fill fluid coupling drives are not capable of accomplishing this level of control. Therefore, the single conveyor required a different drive technology.

Given the enormous cost of any delays to the operation of a longwall, a single conveyor with an intermediate tripper drive is the preferred approach. The problem we were faced with is: can this be accomplished economically?

Economics of Drive Controls

Drives can be separated into those that achieve control through mechanical means and those that control speed and torque electrically. The various drive options were compared in their capabilities, maintenance, safety and costs. The mechanical options considered were fixed fill fluid couplings, variable fill fluid couplings, and variable mechanical transmissions. Each of these involve varying the flow of oil or other fluid to provide control. The electrical control systems evaluated were AC vector drives, AC variable frequency drives, and DC motors. The complete costs, including electrical controls for each option, were compared against the fixed fill fluid coupling drive the mine was using. These results are shown in table 1.

Table 1. Relative costs of drive systems considered.

Drive System	Percent of cost (compared to fixed-fill fluid coupling)
Existing fluid coupling	100
Variable fluid coupling "A"	118
Variable fluid coupling "B"	140
Variable fluid coupling "C"	135
Variable mechanical transmission	134
AC vector	139
DC drive	124
AC DTC variable frequency	104

Variable Frequency AC Drive

After careful consideration of the capital costs, operation and maintenance costs, installation and portability issues, and the reliability of each option, the conveyor design team chose the ABB ACS600 variable frequency AC drive. There were several features of the ABB system that brought us to that decision. First, the ABB provides real torque and speed control without a tachometer or encoder feedback. Other AC variable frequency drives require a motor equipped with encoders to feed back position and speed to the controller. The ABB also provides the best available torque accuracy and response time for optimal load sharing between motors. This is especially important for our tripper application. The ABB also provides the very high starting torque required by the conveyor application (up to 200 percent of motor starting torque). Also, the ABB is very efficient and can handle the wide voltage fluctuations found in underground power systems. Finally, the ABB uses computerized system tuning, giving a quick and easy way to adjust to the individual characteristics of each motor, and has data logging capabilities.

Field Testing the Drive System Capabilities

After a vendor was chosen, the next step was to field-verify the capabilities of the drive system. At the time we were considering this new technology, the only place in the U. S. utilizing the ABB ACS600 was an underground trona mine. Several team members visited the trona mine and observed the ABB drives being used with standard (non-inverter) motors driving low P.I.W. belting in a very harsh environment. We also got a good look at the packaging of the drives, which is important due to the portability requirements and the necessity to disperse the heat generated from the drives. The trona mine personnel were very favorable to the ABB drives. They had several conveyors driven by variable frequency AC from ABB and other manufacturers. They rated the ABB drives the highest.

Before a final commitment was made, the chosen vendor had completed a drive system for an underground coal mine. Design team members traveled to that mine to see a quad motor drive system in operation. There, the team found perfect load sharing between the four motors even when the motors were coupled to speed reducers with different ratios. In other words, the torque was evenly divided between the motors even when they weren't operating at the same speed. The team also saw a belt storage unit for a longwall belt that was powered by a winch controlled by an ABB VFD. In this application, the motor was holding torque at zero speed. After this second favorable report in an application identical to ours, we proceeded with the project.

ABB DTC UNDERGROUND CONVEYOR DRIVE SYSTEM

The ABB DTC underground conveyor drive system consists of these main components: the drive enclosure, the PLC enclosure and the safeties enclosure. A drive enclosure is required for each VFD or motor used. It is a steel enclosure mounted on skids and contains the ABB ACS600 (laid down on its side) and an air to air heat exchanger. The overall dimensions are 9'-8" wide by 3'-4" high by 2'-8" deep. Figure 1 shows a photo of the controller. The second enclosure contains the PLC and the Human-Machine-Interface touch screen. The size of the enclosure is 24" wide by 36" high by 12" deep. The third main enclosure contains the safety interfaces. This can be located near the beltline to connect to remote stations, deluge systems and sequence controls. It measures the same as the PLC enclosure. Figure 2 shows the PLC and safeties enclosures.

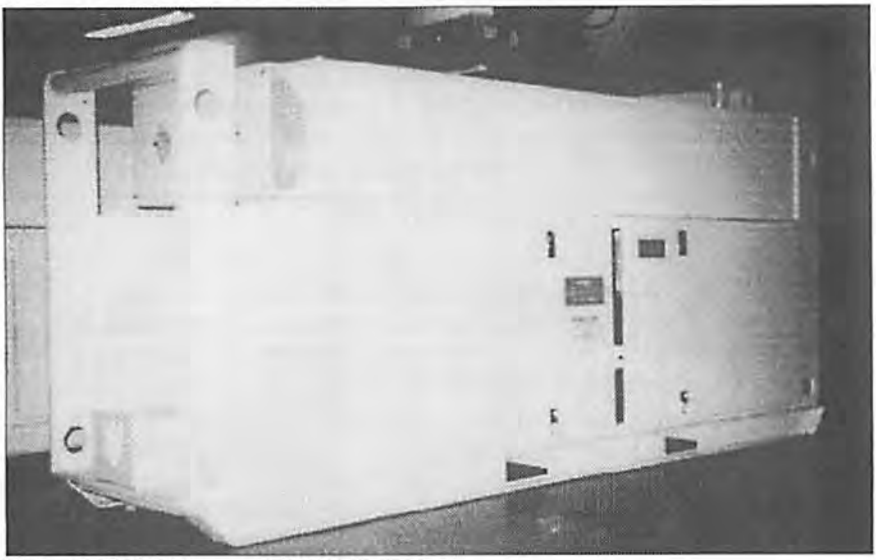

Figure 1. VFD drive controller.

Figure 2. PLC and safeties enclosures.

The tripper conveyor for our long panel consists of two 250 horsepower motors on the main drive and two 250 horsepower motors on the tripper drive. Each drive has a PLC, and each motor is controlled by a VFD. The individual VFDs are interconnected through profibus and peerlink communication links to achieve balanced load sharing across all motors. Figures 3 and 4 give the layout of the control system for the conveyor. The following describes the control logic.

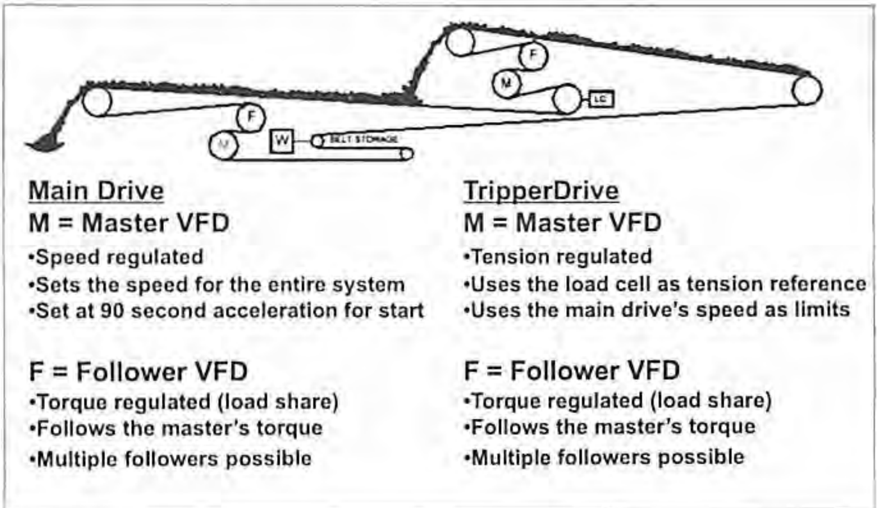

Figure 3. Main and tripper drive control systems.

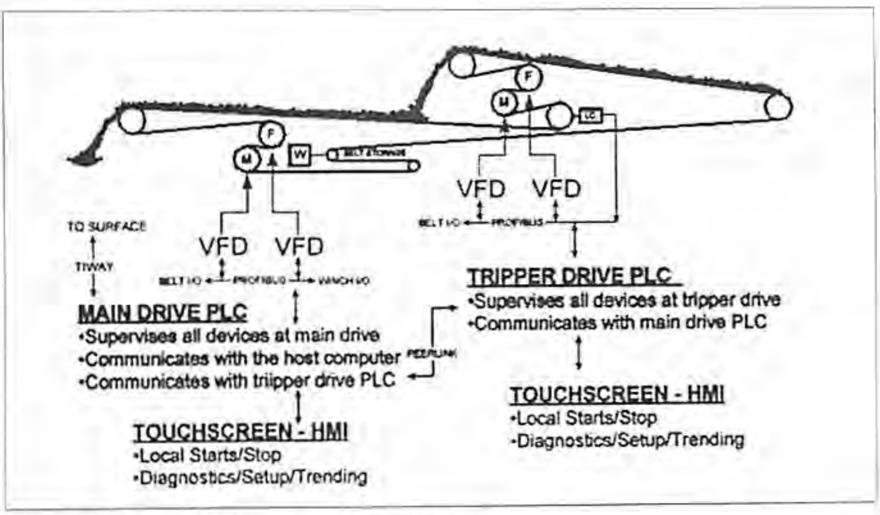

Figure 4. Equipment layout of control system.

Control Logic

At the main drive, located at the head or discharge end of the conveyor, one motor and VFD sets the speed and acceleration during start-up for the entire system. On start-up, it is this first motor, or master, that brings the conveyor up to speed according to a pre-determined acceleration ramp (usually set at 90 seconds) and then holds the conveyor at the desired operating speed (normally 50 percent to 110 percent of synchronous speed). The second main drive VFD is the follower VFD. The follower VFD is torque regulated to achieve balanced load sharing between the master and follower. The follower VFD uses input from the torque of the master VFD to control power input to the second motor. Multiple followers are possible, and they all are regulated by the master.

At the tripper drive, there is also a master VFD and a follower VFD, with the follower being torque regulated to match the torque of the tripper drive's master VFD. The difference between the tripper and the main drive is that the tripper master VFD is tension regulated. The amount of power supplied by the tripper drive is based upon measured tensions taken outbye the tripper. The boost given by the tripper is increased or decreased to maintain a given range of belt tension. The tension is measured by load cells and fed back to the tripper master VFD. Also, the speed of the main drive's master is fed back to the tripper master to set the limits of the tripper drive's speed.

Monitoring and Control

The conveyor system can be monitored and controlled through a graphical operator interface (Human-Machine Interface) in the PLC enclosure. Figure 5 shows an example of one of the display screens. The screen is touch sensitive allowing the operator or maintenance person to view a number of diagnostic and control displays. For example, the speed of the conveyor can be changed "on the fly" by simply touching the screen at the proper position.

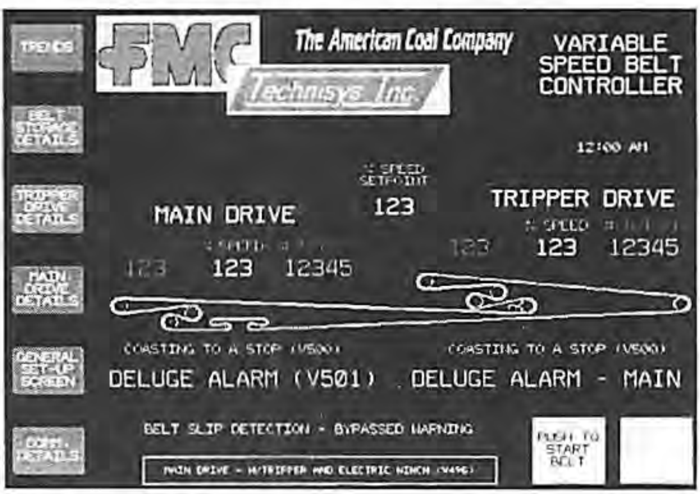

Figure 5. HMI touchscreen.

INSTALLATION AT THE GALATIA MINE

The first VFD installed at Galatia was on the 13,000 foot long 1st West Panel. The main drive VFD was installed during development without a tripper drive. After the panel development was complete, the tripper drive was installed before the start of longwall retreat mining. This allowed some testing and fine tuning without the risk of delaying longwall production. Slip detection and tension deviation indicators were added as a result of this initial testing. No problems were encountered during development; however, some tripper drive "tension deviation" shutdowns occurred during start-up after the longwall began. These were corrected through fine-tuning the response times to the load cell feedback.

The third VFD system was installed in the 2nd West Panel on development. Since the loading rate of the continuous miner is only a fraction of the belt's capacity, the VFD was used to operate the conveyor at 50 percent speed to reduce the wear on the conveyor components and belting. A VFD system was also installed to drive a winch-type take-up/storage unit on this panel. We had gained enough confidence in this technology to utilize it in an application where the motor must hold constant torque at zero speed.

A fifth VFD system was scheduled to be installed in the 3rd West Panel. However, we were experiencing some difficulty on the other side of the mine with another panel conveyor. On that panel, the length and lift of the conveyor was pushing the limits of our 500 horsepower fluid coupling drives and 750 piw belting. Numerous delays were caused by overloads and belt breakages. The fluid coupling was removed, the motor was directly coupled to the speed reducer, and a VFD was installed. All overloads and belt breakages were eliminated. This is attributable to the high efficiency of the VFDs and the long, gradual startup allowed compared to the fixed fill fluid couplings.

FUTURE APPLICATIONS

Future applications for VFDs at the Galatia Mine being considered include high horsepower devices in weak power systems. Examples include surface fans or pumps that must operate on rural power lines that cannot tolerate large starting currents. Other applications might be those requiring speed control and high torque or high inertia starts such as conveyor belts, longwall face conveyors, fans or pumps. The VFD could also be utilized in any system using hydraulic or hydrostatic drives. An all-electric drive using VFDs would provide better controllability and efficiency and would eliminate the maintenance and other concerns of using hydraulic oils for control.

CONCLUSION

In closing, we would like to share some of the lessons learned from our first application of this new technology at Galatia. First, when choosing a systems integrator for your variable frequency drive, make sure they fully understand the capabilities of the ABB ACS600. It is very important to let the VFD do what it does best and not try to over-complicate the PLC program logic. It is best to fully utilize the features of the VFD. Second, if you are developing a "first system" that is untried anywhere else, give yourself plenty of time to bench test it in a shop environment. It is much easier to troubleshoot and fine-tune in a shop, than if the drive is installed in a production application that cannot be shut down for more than a short time period.

Tom Denton: I would be happy to answer any questions now.

Question: The VFD was manufactured by ABB, but the system was put together by FMC, is that right?

Tom Denton: Yes, FMC in partnership with Technysis out of Salt Lake City.

Question: How does elevation affect your system? In the length of your belt is there an elevation change?

Tom Denton: Obviously, you have to take elevation change into account when you do your calculation for horsepower. Then you must evaluate the effect of serious declines or large changes in elevations on the tension calculations at the tripper point. It may result in using the tripper in a braking situation.

John Wilson: Do you know if they are using this system at the Twentymile Mine in Colorado?

Tom Denton: As far as I know, they are not using this identical system.

Question: Bob, do you get any complaints from the power company using these?

Bob Conn: No, these systems have inherent isolation from the rest of the power system because of each respective belt transformer. Any harmonics from the variable frequency drives would not be seen by the power company. Any VFD manufacturer must be concerned with harmonics caused by the VFDs. Some applications require a special isolation transformer, especially with the 4160 volt systems we've seen. But in mining conveyors underground, you typically have belt transformers that serve this purpose and don't require any additional equipment.

Question: Do you have any other equipment on the same transformer secondary? What type of ground monitor do you use?

Bob Conn: We predominantly use tone ground monitors for low voltage equipment. However, tone type monitors are not recommended for use with VFDs. We use a redundant grounding system that is acceptable to MSHA, in lieu of ground monitors.

Question: This is obviously on the same power split as the longwall. Do you have voltage problems with this system?

Bob Conn: No. These systems are very tolerant to the voltage variations that occur with the long power supply cables that we have supplying our longwall equipment. The VFDs don't offer any motor inrush current, and they can operate at plus or minus ten percent of rated voltage. They can operate at even wider variations in voltage for short periods.

Mark Cavinder: Thank you very much, Tom. The next paper is entitled "Surface and Underground Paste Technology Applications in Coal Mining and Utility Industries." It will be presented by Bill Cincilla.

Bill is currently senior project manager for Golder Paste Technology, Ltd., a subsidiary of Golder Associates based in Denver, Colorado. He holds a B.S. in geological engineering from the Colorado School of Mines and an M.S. in mining engineering from Penn State. He is a registered professional engineer in several different states in the United States. So, Bill, we look forward to hearing what you have to tell us.

William Cincilla: Well, I am bringing up the rear here in more ways than one. Most of the talks you heard here today were about product— making product, controlling product—and I am going to be talking about the other, sort of the butt end, of the process, which is the waste end, where I spend most of my career. And I'll apologize in advance that most of these things I will be talking about today are applications that were developed in hard rock mining. So, as you listen to the terminology I use in my presentation, keep in mind that you can substitute coal fines or whatever words make sense there. Before I get into the specifics of what is known in the literature as paste technology or paste backfill, I am going to give you a five-minute primer on the evolution of waste practice predominately in the hard rock mining industry. Hopefully, when I get into the balance of my discussion, you'll understand how these things are coming together and are not just for the structural underground applications that have been kind of a hallmark of the paste backfill industry. Some of these that I will be talking about are things like material properties and geotechnical issues. This is a big all-encompassing subject to talk about in a half an hour. Most times we have more than a day to talk about some of these things. So, I apologize in advance if I skip over things.

[Mr. Cincilla's paper was not available for publication.]

Mark Cavinder: Thank you, Bill. I would like to offer my appreciation for your attentiveness and support, and I would like for all of you to join me in giving a hand to everybody who made a presentation this morning. I appreciate working with Phil Ott on the program committee in lining up the speakers this year. There is an interesting session tomorrow, which is more heavily weighted to the underground than the one today. I look forward to seeing you all here if you can make it back. That is the end of our technical session this morning.

Heinz Damberger: Just a reminder. Visit our vendors; they are waiting for you.

FRIDAY MORNING

BUSINESS MEETING

Gregg Bierei: Good morning. I am Gregg Bierei. I would like to open the business meeting of the 106th year of the IMI. Our agenda includes reports from all the committees, and we'll start with the Secretary-Treasurer's report by Heinz Damberger:

Heinz Damberger: Okay. Everybody always guesses how many people are attending: 366 have picked up their pre-registration so far or registered yesterday and this morning; 146 of those are exhibitors. We lost 30 pre-registered people from Freeman United. As most of you probably know, Freeman has a strike going. They sent in pre-registration for all their people, but only two of them are here; the rest of them are at the mines. Including those, I think we might have about 400 this morning. Compared to last year, we are down significantly; we had about 500 or so. There will be some more coming in this morning, so I think we will end up somewhere between 400 and 450 *[final count 437 (167 coal people, 244 vendors, and 26 students)]*

Membership is holding fairly steady. Our maximum about ten years ago was around 1,200; we are down to 946. The impact of a shrinking coal industry hasn't shown up in membership as much as in attendance. All of this obviously has a major impact on our finances, and the Executive Board has been struggling with this for the last three years or so, trying to come up with ways to either cut expenses or increase income. We have done several things: increased dues last year, and this year rented only part of this facility instead of the entire building saving us about $1,200, which I think worked out real well. Half of the exhibit hall that we still have is full, and, in fact, we have a little overflow into the Cahokian Room in the conference wing. The number of exhibitors, by the way, is up a little from last year, which is surprising.

Overall, looking at our budget for this fiscal year which ended August 31, we are again in the red, and I've been telling the Board that we cannot continue to do that for very much longer, because there are times during the year when we have big bills—when we pay for the Proceedings, for instance—that our balance drops uncomfortably low. We need to make decisions to balance our budget.

This year, the end-of-year cash balance dropped by about $7,000; it was $16,280. However, at times during the year the balance drops even lower. Actually, the decrease in cash balance was not quite as bad as it appears, because we made a one-time payment of about $2,800, money that we had collected for a book on "The Pictorial History of Coal Mining In Illinois." Some of you may remember that at the Centennial meeting Chris Ledvina announced the publication of this book; it has not been published yet, but he promises to do so soon. The Board, on my recommendation, decided to transfer this project to the National Museum of Coal Mining in West Frankfort. Chris Ledvina founded the museum and is its president. It is very logical for that project to be there. So we transferred the money we had collected from people who ordered the book several years ago, to the museum. That is a one time payment of a little over $2,800. Thus, our drop overall is not quite as bad, but it is still over $3,000.

Our projection for this coming year, using a conservative approach, is that we would again be down by $2,000 to $3,000 if we don't do anything. Yesterday, I recommended to the Board a $2,000 cut in our $10,000/year scholarships and a $2,000 reduction in the salary for the Administrative Assistant. The Board accepted the $2,000 decrease in salary but delayed final action on the scholarships to its spring meeting.

The other subject we discussed, and I should mention that here, is that I have resigned as Secretary-Treasurer, after 20 years in the position, and recommended to the Board that Paul Chugh replace me in the slate. The Board accepted, and so, after this meeting here, I will no longer be your secretary. I hope that Paul can turn things around. But that is not the reason I am resigning. I plan to resign from the Survey in about a year and will move away from Illinois; so I thought it would be best to resign now to assist in the transition. I have enjoyed my time with the IMI and made many friends over the years.

I have copies of the financial report here. Our Auditing Committee signed off on it and said it was okay. If you want to see details or just the summary, I have a one-page summary here. And if you have any questions, I would be happy to answer them.

FINANCIAL STATEMENT SUMMARY

Cash Balance Beginning 9/1/97	$22,826	Cash Balance Ending 8/31/98	$15,780
INCOME		EXPENSES	
Advertising	14,787	General Operating Expense	24,689
Annual Dues	15,705	Annual Meeting Expense	20,308
Luncheon Receipts	2,100	Publication Expense-Proceedings	8,647
Exhibit Fees	16,273	Scholarships	10,000
Registration Fees	3,250	Mining History Fund	2,868
Short Course	0	Subtotal Expenses	66,513
Interest	1,104		
Convention Raffle	1,117		
Donations	2,725		
Miscellaneous	231		
Vendor Fees	1,475		
Convention Cash	700		
Subtotal Income	59,467		
TOTALS	$82,293		$82,293

ASSETS SUMMARY

	FY 1996/97	FY 1997/98
Cash & Savings	23,326	16,280
Equipment	15,257	15,257
TOTAL ASSETS	38,583	31,537
1997/98 LOSS		-7,046

Gregg Bierei: Thank you, Heinz. A report by the Nominating Committee, Darrell Auch.

NOMINATING COMMITTEE REPORT

Darrell Auch: The president for this coming year was supposed to be Steve Rowland. He has left the area, so in succession, everybody has moved up a year, and, as a result, Mark Cavinder is nominated to be president for next year. The slate is:

President	Mark Cavinder, Old Ben
First Vice President	Phil Ott, Freeman-United
Second Vice President	Will Border, Joy
Secretary-Treasurer	Y. Paul Chugh, SIU
Board Members	Dave Finnerty, Arch
	Howard Schultz, Monterey
	Steve Short, Sugar Camp
	Maynard St. John, The American Coal Co.

[There was a motion to approve the slate; seconded and the slate was voted in unanimously.]

Darrell Auch

HONORARY MEMBERSHP COMMITTEE REPORT

Gregg Bierei: We have a report by the Honorary Membership Committee. We changed the procedure this year by which nominations were solicited for the honorary member. During the years before, nominations were picked by the committee at large; now we are accepting nominations for the honorary member. Terry Bouvet is not here today; he was the chairman. He had received two nominations. The nomination selected and approved by the Board was Ron Morse of the IL EPA. It will be announced during the luncheon this afternoon.

Heinz Damberger: I think everybody knows Ron; he used to be Director of the Department of Mines and Minerals for a number of years and Director of Safety at Sahara before, and he is a long-time strong supporter of the Illinois Mining Institute.

Gregg Bierei: The next committee report is of the Advertising Committee. Jim Zwahlen. *[Co-chair, not present]*

ADVERTISING COMMITTEE REPORT

Heinz Damberger: I was at the Advertising Committee's meeting Wednesday afternoon. The committee has basically two activities: the advertising for the Proceedings and securing exhibitors for our exhibits. This is not an easy job, as I am sure you realize.

The committee is quite concerned about the future of the IMI, and we had a long discussion about some of the things that could be done, very similar to the discussion that the Board had yesterday. The committee recommended very strongly that the Board approach the Illinois Mine Rescue group to see if we could combine the annual meetings of the two organizations. The advantage for the coal companies would be that they will only have to send people to one event each year, rather than two; this should increase attendance to both meetings. The mine rescue competition has been held in Benton for many years, and it is not going to be easy to change things. The Board, at the recommendation of the Advertising Committee, appointed a committee to work with the mine rescue organization to see what can be done; I believe that this will happen, and it will be a very positive development.

Mark Cavinder, our new president, is going to chair that committee. Both organizations are having difficulty working out the details, but creating some synergy will be advantageous to both groups.

Overall, the Advertising Committee is doing real well. Advertising in our Proceedings has dropped down some, but not very much. It is really to the credit of the committee that we are able to hold on to the ads that we have and the exhibitors at our meeting. As I told you, the exhibit hall is filled and we actually have a few more exhibitors this year than last. However, we didn't get some of the large exhibits this year; so that is the reason for some of the drop in income. But we are holding on. This committee is very important to us.

Gregg Bierei: I would like to thank the members of the Advertising Committee. They really get things done for the IMI, and we appreciate their support.

Our next committee report is by the Scholarship Committee.

SCHOLARSHIP COMMITTEE REPORT

John Wilson: As chairman of the Scholarship Committee, it is my job to tell you what we have been doing and follow up with a little report from each of the colleges, the recipients of the scholarships.

The committee is not very big; there are three of us. We communicated by e-mail, fax and phone. Last year, we were able to benefit 15 students. As Heinz mentioned, it is a difficult situation and scholarships might drop next year; however, we hope we can keep the scholarships at the current level. Next year is going to be a tough year. We hope we can keep it at the $10,000 level by reducing the cost of running the IMI, by using student help, or generating additional income.

At this stage, I would like to ask if there are representatives from the Illinois Southeastern Colleges here?

Illinois Eastern Community Colleges

John Howard: It is my 23rd Institute, and for the last eight, I've had the privilege of giving the scholarship report. I want to say we find things relatively stable. We are maintaining four locations in southern and central Illinois. In the last few weeks, we had four new miner classes: two underground, two surface.

This year, we have three recipients, all from our cooperative arrangement with Southeastern Illinois College in Harrisburg. They are full or part-time students who are working in the industry, trying to improve their skills and learn new trades. The three recipients are Adam Deal, Tim Wilson and Ray Quertermous

On behalf of the faculty, staff and administration, and student recipients at Illinois Eastern Community Colleges, I again want to thank the Illinois Mining Institute for its continued support.

John Wilson: Dr. Paul Chugh from SIU.

Southern Illinois University

Paul Chugh: Thanks, John. On behalf of Southern Illinois University, I would like to thank IMI for supporting the mining engineering program at SIU. Before I give you a little report on the Department, I have a good surprise. I have one of our ex-students, Randy Simpson; can you please stand up? Randy is currently a senior project manager with BHP Resources. We are really pleased to have you, Randy. Do you want to say a word or two about your experience with us?

Randy Simpson: I just want to thank the Illinois Mining Institute. When I was in college, I received scholarships from the IMI, and I am very grateful for your support. I am eleven years in my career now, and I sincerely appreciate it. Thank you.

Paul Chugh: He was on his way to Collinsville, and he said he wanted to say hello to me; I really appreciate his stopping here.

The department is in very sound health, and we are becoming broader and broader by the day. I guess the way we are going, maybe in five years, we'll be more like a mineral resources engineering department rather than a mining engineering department. Some of you may not know, that over the last year, we changed the name of the department from Mining Engineering to Mining and Mineral Resources Engineering Department. That is an effort to make us more and more broad-based. As I tell my faculty, I would like to have a much broader foundation for the department than just only mining. And as I discuss with you a few things, you will realize that we are moving in that direction.

In the academic program area, we currently have 28 juniors and seniors for the undergraduate program. We have ten master's candidates and four Ph.D. candidates. We graduated one Ph.D., and he was picked up by the industry; he went for about $65,000. So, we are really happy that we are placing our people.

All the undergraduate students were placed in summer jobs, and all the graduates were placed in full-time jobs, also. They went to U.S. Gypsum and White County Coal; one went to the aggregate industry and one went to the phosphate industry down south. So, even though we are producing a smaller number of graduates, they are being well-received in the industry, and they are doing well. Randy Simpson is a good example of the type of people we are producing.

Our research remains very strong. We bring in, externally, a little over three-quarters of a million dollars a year. We have five post-doctoral people in the department, which is probably the largest of any school I know of in this country. There are three areas we are working on in a big way; one is management of coal combustion by-products. Another area is the processing of fine coal. The third area we are going into in a big way is modifying mining systems to improve the profitability of Illinois coal.

Some of the major developments to watch for from our department will include a commercial facility within the next year which will produce fly ash-based mine timbers, mine ventilation blocks, and a rib control system. If you have not seen the timbers, they are sitting at our booth. We have had very positive response, and I am pleased to report this development to you.

In another area, Dr. Honaker is doing a lot of good work in the fine coal processing area. He will be doing some field demonstration work. We received a half million dollar contract from DOE which will start December 1, and, as we have reported, we are trying to hire as many laid off coal miners as we possibly can to support our activities.

Another area that we are going into in a big way is micro-generation of power at the mine site. Dr. Bradley Paul has been working with Duke Energy; we are very hopeful that we will get that contract, because the potential for micro-generation is very good.

The final area that you should be looking for is field demonstration, dealing with waste coal in slurry ponds to take care of environmental problems. We have done a lot of work, and things are looking pretty good.

In the service area, we have done a lot of technology transfer activities to support DCCA, OCDM, and ICCI work. We also developed a joint-master's program with China University of Mining Technology. They will spend one year over there and then they will come only for one year with us to get their master's degree. I think that is going to help us tremendously.

We were awarded $4,500 in IMI scholarship monies. We used it to support seven students. Their names are: Stewart Adams, Curtis Eichen, Matthew Feist, Mark Noel, Chris Russell, Howard Thomas and Bjorn Ljunggren. They all have GPAs over 3.0. One last comment, Howard Thomas was given the National Stone Association's scholarship this year for $2,500. We are very happy to have these students. We had about seven or eight people here yesterday, and I hope to have five or six here again today.

Once again, I want to thank IMI for supporting our department. Your support is being effectively utilized to assist the coal industry of Illinois. Thank you so much.

University of Missouri-Rolla

John Wilson: Thank you, Paul.

We are from this little school in Missouri. I haven't prepared a speech, but I will pass on a few comments on what is happening at UMR.

At UMR we have maintained our enrollment at approximately 100 undergraduates and eight graduate students. We have tried to keep our undergraduate-to-graduate student ratio this way because, frankly, there is a much greater demand for our graduating bachelor degree mining engineers, and very few students want to stay for higher degrees because of the variety of good job opportunities available. We have noticed, however, that there has been a change in the ratio of graduates in terms of nationality. Three quarters of our grad students are U.S. citizens, and the remainder are from foreign countries. This is the reverse to what has been the case for many years, and it is gratifying to see that we have some Americans doing graduate work.

We have had a few changes in the faculty during the past year. We were sorry to lose Dr. Larry Grayson to NIOSH, where he was appointed as the Associate Director of Mine Health and Safety. His position was filled by Dr. Tad Golosinski who came to us after five years as Head of the Mining Department at the Western Australian School of Mines. Tad's specialties are surface mining, heavy equipment, maintenance, planning and mine hoists. We also lost an Assistant Professor earlier this year. He has been replaced by Dr. Karl Zipf who comes to us from the University of Queensland where he has been teaching for the last two years. Prior to the stint overseas, Karl spent many years with the USBM where he developed his expertise in rock mechanics, strata control and mathematical modeling. Karl will join the department in January 1999, and we believe he and Tad Golosinski will be significant assets to our department.

As usual, our students were as active as ever. Student body activities over the last year have included hosting the Intercollegiate Mining Competition (Mucking Competition). Twenty men's teams participated this year which included participating teams from Australia, Canada and as far afield as Alaska. Of course, the usual western U.S. schools also participated. As in the previous six years, there were also women's teams, and, on this occasion, 11 teams entered the competition. Rolla's women's team took first place for the fourth successive year, and our men's team placed second.

This year we entered two mine rescue competitions and took third place in one of the regional competitions; quite an achievement. We were invited to the finals of the metal and nonmetal mine competition in Las Vegas in July. Although we placed fairly low in this competition, it was no surprise since all our team members were working at their summer jobs and didn't have a chance to practice.

In the last few years, we have broadened the charter of the department in what we believe is an appropriate way. We have made a concerted effort to become more global in our mission. We now have student exchange programs between UMR's Mining Department and similar departments within the Western Australian School of Mines, University of New South Wales, University of Pretoria in South Africa, La Serena in Chile and Zacatecas in Mexico. We exchange interested students for one semester and ensure that the students take only mining related courses. These exchange programs provide a valuable experience to the students and put them in good stead for the expanding globalization of the mining industry.

Another area that we have been placing greater emphasis on is in offering extension programs/short courses to meet industry needs. We believe there is a gap between graduating from a mining school and rising through the ranks as a full time employee of a company. During this time, there are technological advances made in the industry that are not always easy to keep up with. So, to help this situation, we have been offering a number of short courses on a variety of topics. For example, we have been offering a practical ventilation course every year for the last ten years. During the last 18 months or so, our faculty have provided short courses on subjects such as advances in underground metal mines, environmental aspects of mining, for miners in Mexico; underground coal mining with particular reference to longwall methods, for the BHP Minerals; fundamentals of surface mining, drilling and blasting in surface mines, for Komatsu Mining Systems; and underground hard rock mining for Caterpillar Inc. In the latter courses, the objective was to educate equipment dealers, distributors and sales personnel about mining industry techniques for which their equipment is used.

I would like to conclude my remarks by saying that we have a strong healthy mining department which we believe is keeping up with an ever-changing mining industry. Thank you for your continued scholarship support and the summer job opportunities provided to our students by IMI member companies.

Gregg Bierei: That concludes the reports by our committees. Are there any other items of business or comments? If not, I would like to make a few announcements.

First, if you are aware of any deceased member of the IMI, please give the name of that person to Heinz or Phyllis Godwin, prior to the luncheon. We have two airline tickets in the raffle along with a set of golf clubs to raffle. The tickets are available for $1.00 apiece or six for $5.

I would like to mention the donations we received in the past year. We have had special donations totalling over $2,700. Those organizations that contributed to the IMI were: Arch of Illinois, A-Z Industries, Consolidation Coal Co., Frontier-Kemper Constructors, Illinois Department of Commerce and Community Affairs, Peabody Coal, Sugar Camp Coal and UMWA, District 12. We thank them for their support this year.

I would encourage people to buy the raffle tickets.

At this time I would like to thank Heinz Damberger. Heinz has been Mr. IMI for the last 20 years, and his support and dedication to the organization has been invaluable. We are all going to miss him and wish him well in the future and in retirement. I think you deserve a standing ovation.

If there is no other business, we will adjourn the meeting. Thank you.

The retiring IMI crew, left to right: Jim Sisco, Pam Sisco, Heinz Damberger, Phyllis Godwin and Dave Godwin.

TECHNICAL SESSION II
Progress in Mine Operations

Phil Ott: Welcome to the 106th annual meeting of IMI. This is the second technical session. We have some good speakers today. I want to thank Heinz for setting this up and Mark Cavinder, who did a real good job getting the speakers lined up.

The first speaker is Malcolm Goodinson. He is going to speak on extensible belt conveyors; the wave of the future. Malcolm works for Huwood International, Continental Conveyors. He comes to us from the U.K.

Malcolm Goodinson: Good morning. Just a little brief on where we come from. Huwood International of the U.K. has been associated with mining since 1911. Just recently, Huwood was acquired by Continental Conveyors, which we believe will do wonders for our projects in new equipment.

My paper today is based on belt conveyors which is our main product line.

Phil Ott opens the second technical session.

THE EXTENSIBLE CONVEYOR SYSTEM

MALCOLM C. GOODINSON

Huwood International/Continental Conveyors, Ltd.
United Kingdom and Winfield, Alabama

INTRODUCTION

Conveyor development over the past 20 years has centered on increased power ratings, longer single flight systems and booster and tripper conveyors, all directed towards increasing output and coal clearance.

The actual conveyor structure alone has changed very little in style and configuration except to cater to the ever-increasing loads demanded by modern mining methods. The downtime associated with belt moves is a product of the lack of development in this area. This paper is devoted to the research and development of a system that considerably reduces conveyor downtime.

EXTENSIBLE CONVEYOR SYSTEM

The research and development of the system was based around a design brief as follows:

- The design must be sufficiently compact to apply in conditions where height and width are limited.
- The conveyor structure would be made up of modules (cassettes).
- Each module would comprise a fixed length of conveyor structure concertinated both horizontally and vertically.
- Each module could be inserted into the conveyor whilst the belt is running.
- Each module would automatically open and set on the mine floor as the cutting machine advanced.
- The extended structure would form the permanent conveyor.

PRINCIPLE OF OPERATION

The conveyor is based upon a concertinated belt-supporting structure supported on a sledge/launching platform. The sledge forms part of the tailend of the conveyor and moves forward as the tailend advances.

The storage section of the sledge contains the cassettes, which are modules of conveyor structure, with a closed dimension of 4 feet, 3 inches extending to 27 feet.

As the tailend advances, the cassettes unfold, sliding off the sledge/launching platform and setting automatically on the mine floor.

METHOD OF OPERATION

The following is a typical loading and installation procedure for the cassette system; all operations can be carried out whilst the conveyor is running:

- Transport one cassette to the loading section of the sledge.
- Lower the track assembly from its stored position to the mine floor.
- Power any cassettes already on the loading deck onto the forward storage area.
- Lower the loading deck to the bottom loading position.
- Power the loading deck onto the track assembly.
- Transfer cassette onto the loading deck and place the return roller in storage tray.
- Elevate the top belt to provide clearance for the cassette.
- Retract the loading deck positioning the cassette between the top and bottom belt.
- Lower the top belt to its normal operating position.
- Raise the loading deck to its operating position.
- Power the cassette onto the storage section and return ram to its parked position.
- Repeat the procedure until the required number of cassettes is on the loading section.
- Finally, connect all the cassettes.

The system is now ready for operation. All operations are carried out on the travelling side of the belt except for the final connecting of the cassettes.

MOVING UP THE BELT

The conveyor return end and sledge advances pulled by the mining machine cassette unfolds as the sledge moves forward and descends the ramp. The attendant places the return roller in the automatic pickup device. As the sledge advances, the structure descends the ramp and sets on the mine floor. The return roller engages automatically as the sledge passes the pickup point. The rate of advance is governed by the speed of the mining machine.

Cassettes can be inserted at any time during the advance, or the sledge can be loaded to suit a particular distance; i.e., distances between cross cuts.

APPLICATIONS TO DATE

Arch Minerals Corporation, Arch Coal, Illinois. The underground operations of Arch Coal at the Conant Mine have recently completed the first panel using the Extensible Conveyor as part of their Archveyor project. The specification for the Extensible Conveyor was as follows:

- Mining System: advancing three entries in room and pillar, with retreating rib pillar extraction.
- Equipment: continuous miner, roof bolter, Archveyor, feeder breaker.
- Duty: 1,500 short tons/hour.
- Extensible: 4,000 ft from inbye of storage loop to feeder breaker.
- Conveyor Belt: 48 inch, 600 p.i.w.

Cleveland Potash Limited, U.K. The underground mine at CPL produces potash through the week and road salt on weekends. This benefits their operation in two ways: while they produce road salt for sale, they extend their roadways. Their objective was to be able to mine salt continuously for the 48-hour period over the weekend, with minimal downtime.

The Extensible Conveyor supplied is a fixed-length system mounted on wheels and is situated between the feeder breaker and the conventional belt structure. The unit is fully closed at the beginning of the cycle. When the machine advance is complete the feeder breaker laying out the structure automatically hauls the Extensible Conveyor out. This allows the mining operation to continue for another 150 feet before the conventional structure is required.

IMC Kalium Colonsay, Canada. This unit will operate in an underground potash mine in Saskatchewan, installed in a 6,000-foot room following a continuous mining machine. The advance will be every 180 feet between cross cuts. The unit will be wheel-mounted because of poor floor conditions.

FUTURE DEVELOPMENTS

The next generation of the Extensible Conveyor System could be track mounted; this would allow greater flexibility of operation and faster move up and retraction speeds. The Extensible Conveyor could also be roof mounted for operations with difficult floor conditions.

CONCLUSION

The development of the Extensible Conveyor System is a major step forward towards a totally continuous mining operation.

Malcolm Goodinson: I would like to thank certain people that have helped us through this project, particularly some of the guys at Arch: Tom Sawarnski, Dan Stickel, and Wes Hofmann, who worked closely with us on this, as well as a good friend of mine Andy Parker. And I thank you very much for your attention.

Any questions?

Question: Is there any coal height limitation? What is the smallest seam?

Malcolm Goodinson: The height is virtually determined on the span. So, up to now, we are just under six feet, but we believe we can get it lower. I guess one of the constraints is that if you bring it lower, you are going to have to bring the sets closer together. There's no detriment in terms of coal handling; it is probably better. But it will increase the number of sets, so it may increase the cost. We are conscious that there are applications that it won't do, six feet and under. Thank you.

Phil Ott: Thank you very much Mr. Goodinson. The next speaker is the Dr. DeBasis Deb. He is going to talk on "Improvement of Longwall Safety and Productivity with Real-Time Shield Pressure Monitoring Using LosCoMS Software." He is a research associate in the Department of Mining and Mineral Resources Engineering at Southern Illinois University at Carbondale.

Debasis Deb: Thank you, Mr. Chairman. I would like to thank IMI for giving me this opportunity to speak in front of you, especially Dr. Chugh.

IMPROVEMENT OF LONGWALL SAFETY AND PRODUCTIVITY WITH REAL-TIME SHIELD PRESSURE MONITORING USING LOSCOMS SOFTWARE

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DUK-WON PARK

University of Alabama
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ABSTRACT

Longwall mining is considered more effective than other underground coal mining methods because it achieves higher rates of extraction with better personnel safety records and a potential for full automation. Fast advancing, wide longwall faces can achieve ever-higher production. However, longwall mining can create unexpected hazardous conditions such as roof falls, excessive face convergence, shield damage and numerous maintenance problems causing safety hazards and sudden interruption of coal production. To combat these problems through the use of microcomputer technology, shield legs are equipped with electronic pressure sensors for monitoring pressure in real-time on the surface. These data provide information regarding face conditions such as high loading zones, low setting pressure of shields, shield maintenance, shearer location, etc.

A Longwall Strata Control and Maintenance System (LoSCoMS) was developed at The University of Alabama to interpret these data in real-time and then applied to forecast face conditions. This system is being used every day at two longwall panels in Alabama to improve longwall safety and productivity.

INTRODUCTION

Longwall mining has grown steadily over the last 25 years in the U.S. producing a record-setting 1.089 billion short tons in 1997. In 1996, seven mines in this country surpassed the five million tons per year mark, placing them in direct competition with some large surface mining operations (Fiscor, 1998). In the same census, it was also found that coal production from longwalls (48 percent) surpassed that of continuous miners (43 percent) and conventional (nine percent) in 1996-97. These success stories for longwall production have been possible due to the installation of high capacity equipment such as shearers, shields, stage loaders, etc., on the face, which improve production from longwalls and provide better health and safety records. It is now believed that to continue this trend in the future, mining companies have to adopt a wider and longer face with higher-capacity face equipment and to minimize the number of longwall downtimes.

A recent survey of an international longwall census shows that the panel widths and lengths are growing in the world at a rate of two percent and eight percent per year, respectively (Reid, 1997). The increase in panel size and the installation of faster and bigger cutting machines at the face results in increasing coal production, but also increases the number of ground control problems, causing numerous production delays. It is estimated that mining companies lose \$150 to \$500 per minute of longwall downtime (Hart et al., 1995). Moreover, the capital cost for mining a wider and longer face has grown rapidly over the last few decades. Thus, it is not economically feasible to undertake a longwall project which may cause excessive ground control problems and interrupt coal production too often.

The LoSCoMS, developed at The University of Alabama, continuously monitors shield pressure data in real-time and subsequently analyzes them to identify possible instability problems at the face. High-capacity shields may provide necessary roof support, but the interaction between the shields, the roof and floor may cause instability. In Illinois coal mines, high-capacity shields do not necessarily guarantee a safer longwall face, due to weak floor conditions. Thus, continuous monitoring of shield pressure is required to understand the interaction between shields and the surrounding strata to evaluate causes of problems and institute proper preventive measures.

LoSCoMS has been used at two longwall panels in Alabama since mid-1996 (Park et al., 1998). For the last two years, this system helped identify many ground control problems and helped reduce longwall downtimes in those panels (Deb et al., 1998). The major features of LoSCoMS include collection of shield pressure data, presentation and analysis of shield pressure, providing maintenance information of every shield and forecasting of forthcoming events at a longwall face. The details of this system and its capacity to improve longwall safety and productivity, are described below.

LONGWALL STRATA CONTROL AND MAINTENANCE SYSTEM

LoSCoMS is a user-friendly and mouse/keyboard operated software system which runs on Windows 95/98/NT. It has the following functions:

- Collection of real-time shield pressure data and transmission from underground to the surface.
- Presentation of current and past data.
- Analysis of pressure history data.
- Providing on-line maintenance information for every shield.
- Forecasting of shield pressures.
- Forecasting of time-dependent pressure.
- Providing information for longwall management.

PURPOSES OF LOSCOMS

Microcomputer technology is employed to collect shield pressure data and transfer them to the surface around the clock. By collecting shield pressure data, the cause of many instability problem such as roof and floor convergence, periodic weighting and broken roofs can be analyzed. The LoSCoMS evaluates pressure data and determines the cause of instability problems, and then, using artificial intelligence techniques, forecasts any forthcoming unusual events at the face. Thus, it is now possible to prevent a catastrophic failure of the face and at the same time enhance safety and stability of a longwall mine. In addition, on-line maintenance information such as leg leakage, faulty sensors, low setting pressure, and low-pressure yielding of shields can also save time and maintenance costs.

TASKS OF LOSCOMS

Monitoring of Shield Pressure to the Surface. Figure 1 shows the schematic diagram of a data acquisition system that connects a headgate computer to the surface computer. Shield pressure data are transmitted from the headgate computer to the optical barrier which is used to protect the system from voltage fluctuation, RS485 to RS232 converter, and short haul modems, all of which are located near the power station (at least 150 ft outby the headgate) (Deb, 1997). Signals are transmitted to a serial port (COM ports) of the surface computer through telephone lines which run from underground to the surface. The LoSCoMS collects data from the serial port and stores them onto the computer hard disk in real-time.

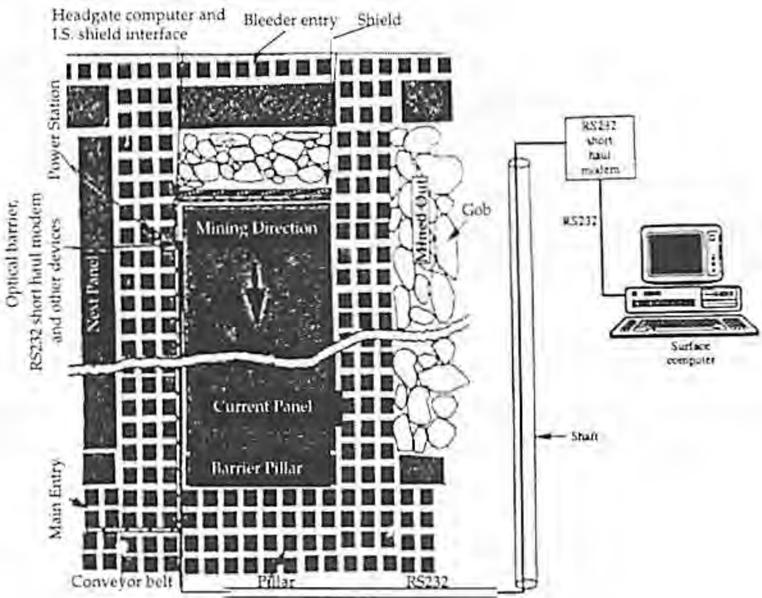

Figure 1. Schematics of surface data acquisition system.

Presentation and analysis of shield pressure. Shield pressure is continuously acquired to analyze shield performance and maintenance problems, geologic roof and floor conditions, periodic roof weighting, etc. Currently, LoSCoMS helps analyze yielding cycles, leg leakage, shield performance, interval and intensity of periodic weighting which, in turn, can be further evaluated for predictive values by an artificial intelligence system to forecast forthcoming events.

Real-time pressure data. Figure 2 shows a typical plot containing a current and setting pressure distribution across the panel using the average pressure value of every ten shields. This plot displays the whole panel pressure distribution starting from the headgate to tailgate for current time. In addition, this plot is updated every minute as the new set of pressure data arrives at the computer. Various combinations of shield groups can be made as desired.

On-line maintenance information such as yielding, leg leakage, low setting, bad sensor and poor performance can also be detected for every shield from real-time pressure data (Deb, 1997). They are plotted and shown using a separate panel view/maintenance window. The location of the shearer or cutting machine is also mapped in this window showing cutting directions.

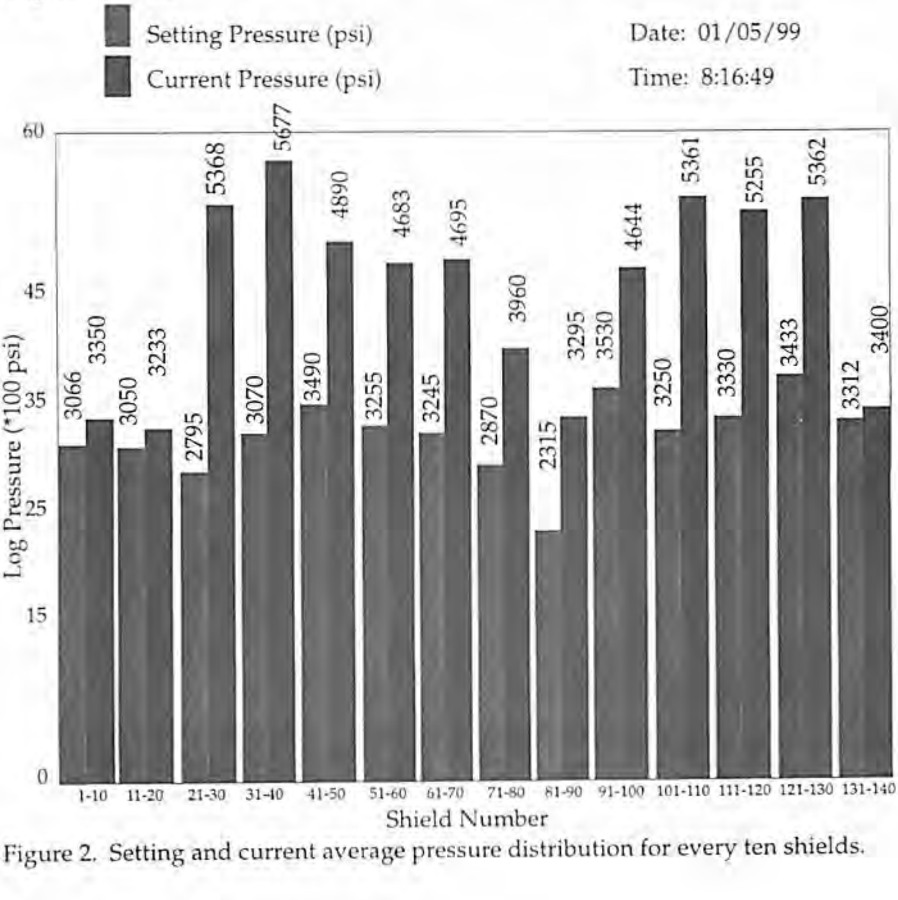

Figure 2. Setting and current average pressure distribution for every ten shields.

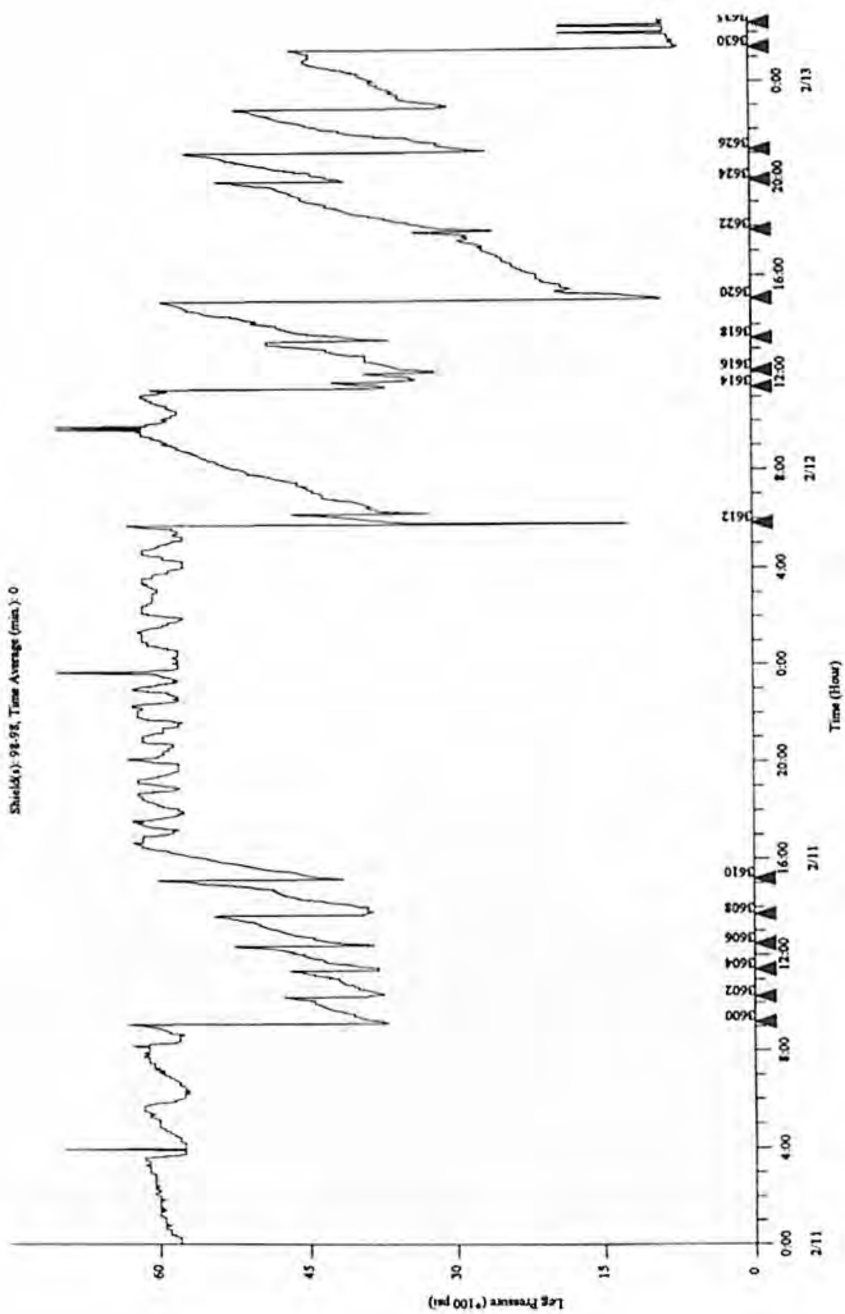

Figure 3. Shield pressure record during a periodic weighting period.

Analysis of yielding pressure. During the periodic weighting time, high shield pressures are recorded with higher roof convergence. Using continuous monitoring of shield pressure, this phenomenon can be recorded for every shield to evaluate the cause and intensity of the yielding. Using this result, proper preventive measures can be taken to reduce longwall downtime due to excessive shield yielding. Figure 3 shows an example of the pressure record of a shield during periodic weighting time in the presence of a strong roof and floor. In this case, the pressure on the shield rapidly increases to yielding limit and stays there until the canopy is disengaged from the roof and lowered down.

Analysis of periodic roof weighting. Characteristics of the periodic weighting in terms of the intensity and interval mainly depend on the thickness and strength of the roof and floor. As an example, the final pressure distribution with respect to the face distance is plotted using LoSCoMS (fig. 4). The vertical axis refers to the shield numbers grouping every ten shields, and the horizontal axis represents face distance from the beginning of the panel. These data are recorded where a thick sandstone layer existed in the roof. Periodic weighting of that rock layer is also shown using triangular boxes where pressure intensity is marked. The average interval between consecutive high-pressure zones represents the periodic weighting interval. If the geological conditions of this mine remain the same, the location of the following high pressure zone can be predicted from this result.

Analysis of setting pressure. It was found that if setting pressure of a shield becomes high in a particular location, final pressure of that shield follows the same trend (Park et al., 1998). This is due to the fact that during periodic roof weighting time when the shield pressure is high, severe roof movement occurs. Figure 5 shows a typical setting pressure distribution plotted using LoSCoMS for a specified face distance for the strong roof and floor conditions.

Analysis of shield performance. Leg leakage occurs when hydraulic fluid leaks from the leg piston. Due to the leakage, pressure in the shield drops and cannot provide adequate support to the roof. At this time, roof convergence is relatively higher. As an example, the pressure distribution of leg leakage is shown in Figure 6.

It is also observed that when the immediate roof is severely fractured (mostly weak roof), shields cannot be set properly with the roof. In other words, the contact between the canopy and roof is not firm enough to provide necessary resistance to the roof load. These phenomena are referred to as poor performance of the shield and can be detected using continuous monitoring of shield pressure through the LoSCoMS, and proper action can be taken to rectify this problem.

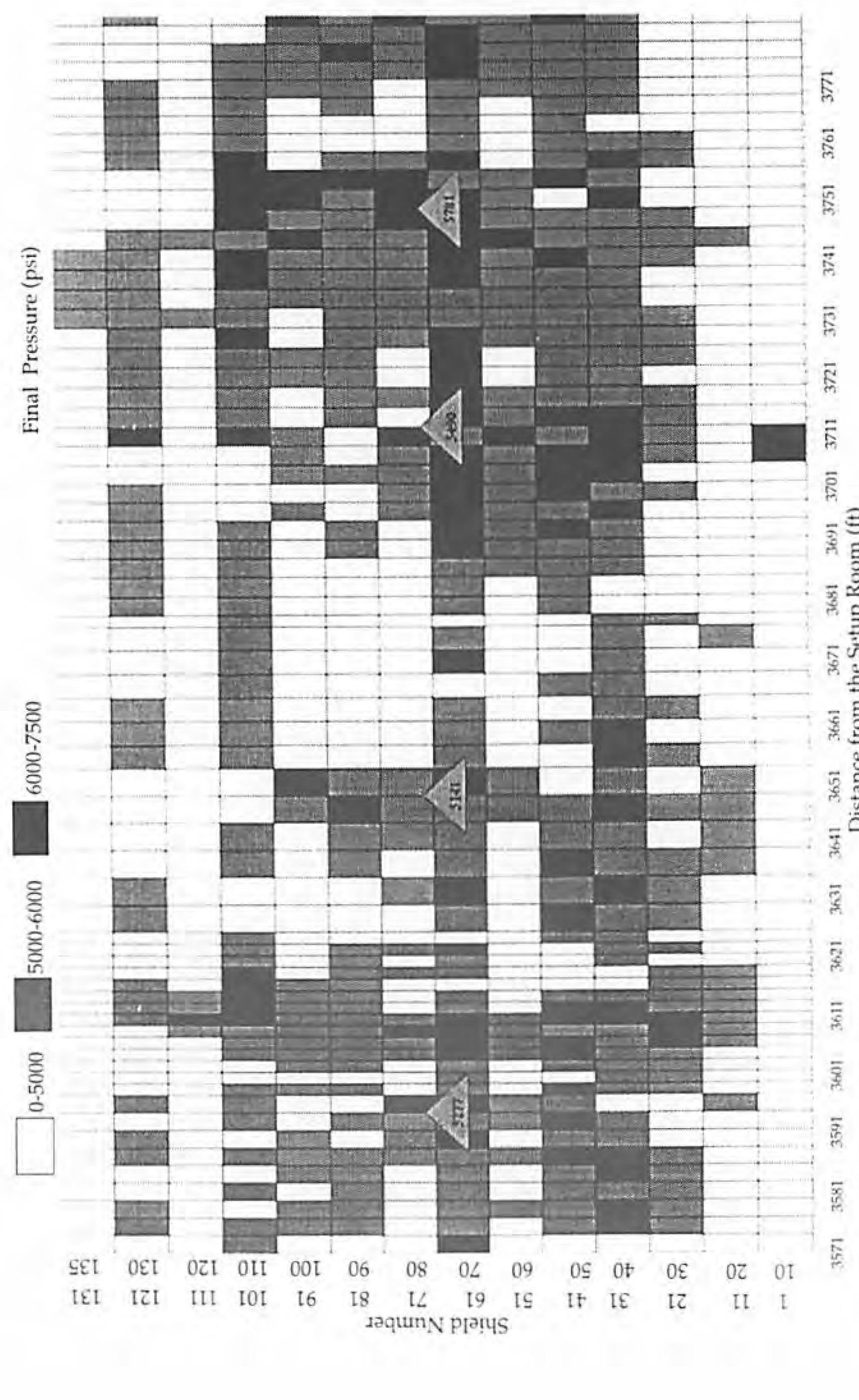

Figure 4. Final pressure distribution with respect to face location.

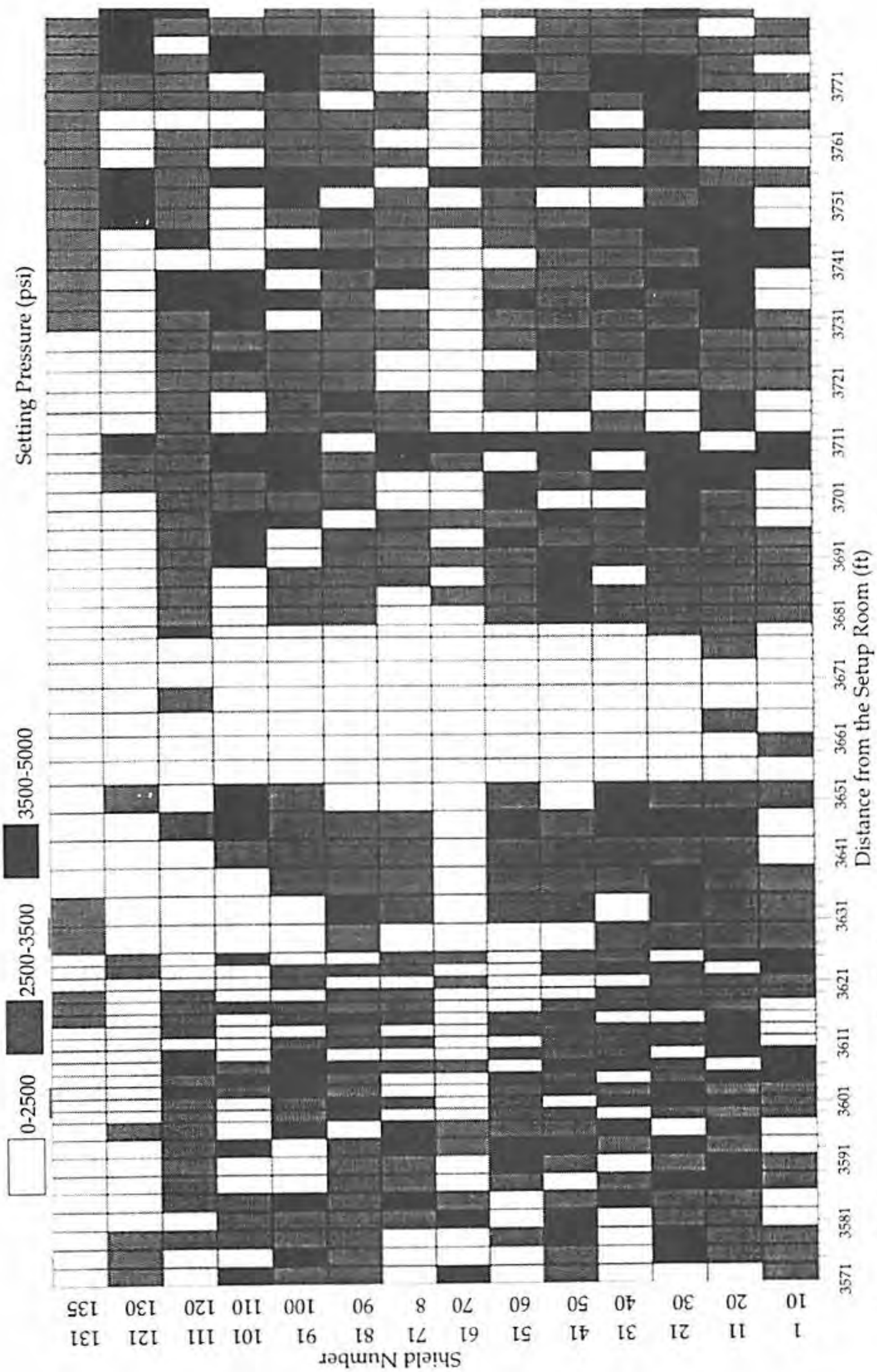

Figure 5. Setting pressure distribution of the same area as shown in figure 4.

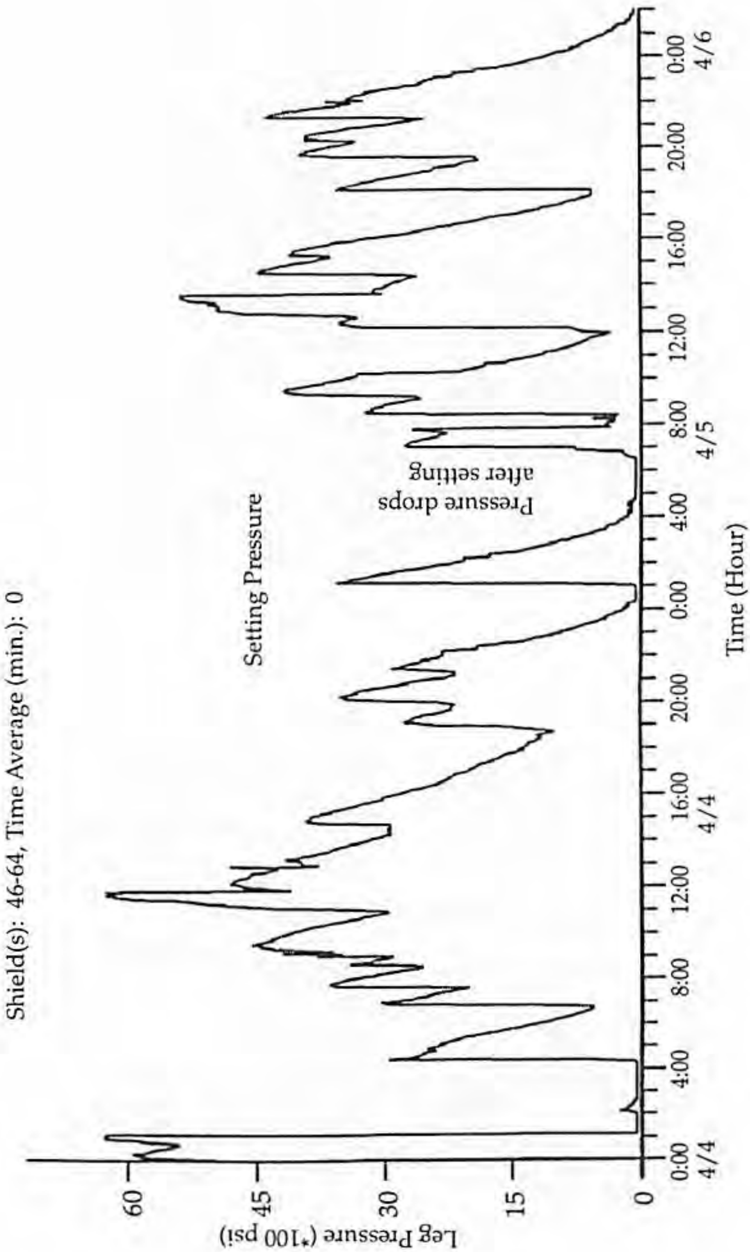

Figure 6. Characteristics of shield pressure during leg leakage.

Maintenance Information of Every Shield. LoSCoMS provides two forms of maintenance information. First, in case of an on-line system, a special window provides the information regarding shield yielding, leg leakage, poor performance, low setting, and bad transducers (Deb, 1997). Secondly, the same information can also be obtained every hour for each shield. The detailed information of each shield is listed hourly showing their yielding time, performance characteristics, leakage information, etc.

Forecasting of Shield Pressure. LoSCoMS forecasts shield pressure of forthcoming mining cycles. Artificial intelligence techniques and statistical analysis were applied to evaluate loading trends from past shield pressure data. Using these results and other geological information, LoSCoMS provides a viable, predictive assessment of longwall stability.

Forecasting of Forthcoming Cycles. The key parameters for forecasting shield pressures are the intensity and intervals of past several periodic weightings, geological conditions of the roof and floor, coal seam thickness and undulation, existence of faults, folds, etc. Neural networks are applied to evaluate the relationship between shield pressure and face distance from these data. Based on this analysis, LoSCoMS predicts the intensity and duration of the next several periodic weightings. Figure 7 shows an example of a forecast for 15 mining cycles depicting past and future shield pressures across the panel. In this figure, periodic roof weighting is predicted.

Forecasting of time-dependent pressure. Shield pressures increase with time when the face is idle. After the face is stationary at a particular location, the roof settles down on top of the canopy and shield pressure increases rapidly for the first few hours (Park et al., 1998). After that period, shield pressure increase is gradual. An extensive statistical analysis was performed to evaluate the characteristics of shield pressure increase vs. time in order to forecast shield pressure during planned idle periods such Sundays, holidays, etc.

Information for Longwall Management

The mine management uses predictions of periodic weighting to improve longwall performance. For severe periodic weightings in thinner coal seams, additional roof or floor must be removed to provide sufficient height for shield yielding while maintaining adequate clearance for shearer operation. Advance knowledge of the location and intensity of these severe periodic weighting events allows management to minimize the amount of out-of-seam material removed. Figure 8 shows an example of recording clearance height (distance from the canopy tip to the top of the face conveyor) at the face with shield pressure distribution for each shift. Clearance height is measured three times in every shift at every 15.24 m (50 ft) interval along the face width. Goal clearance heights are selected from the pressure distribution. From the measured heights and coal seam thickness, a volumetric calculation of the out-of-seam material to be removed can be performed for every shift. Using the predicted location of the periodic weighting, coal cutting height can be set at the appropriate location, thus minimizing the amount of out-of-seam material in the produced raw coal. Thus, longwall operations can be streamlined creating less rock cutting at the face and minimizing plant rejects. Apart from this, LoSCoMS output is also used to schedule planned maintenance and idle periods.

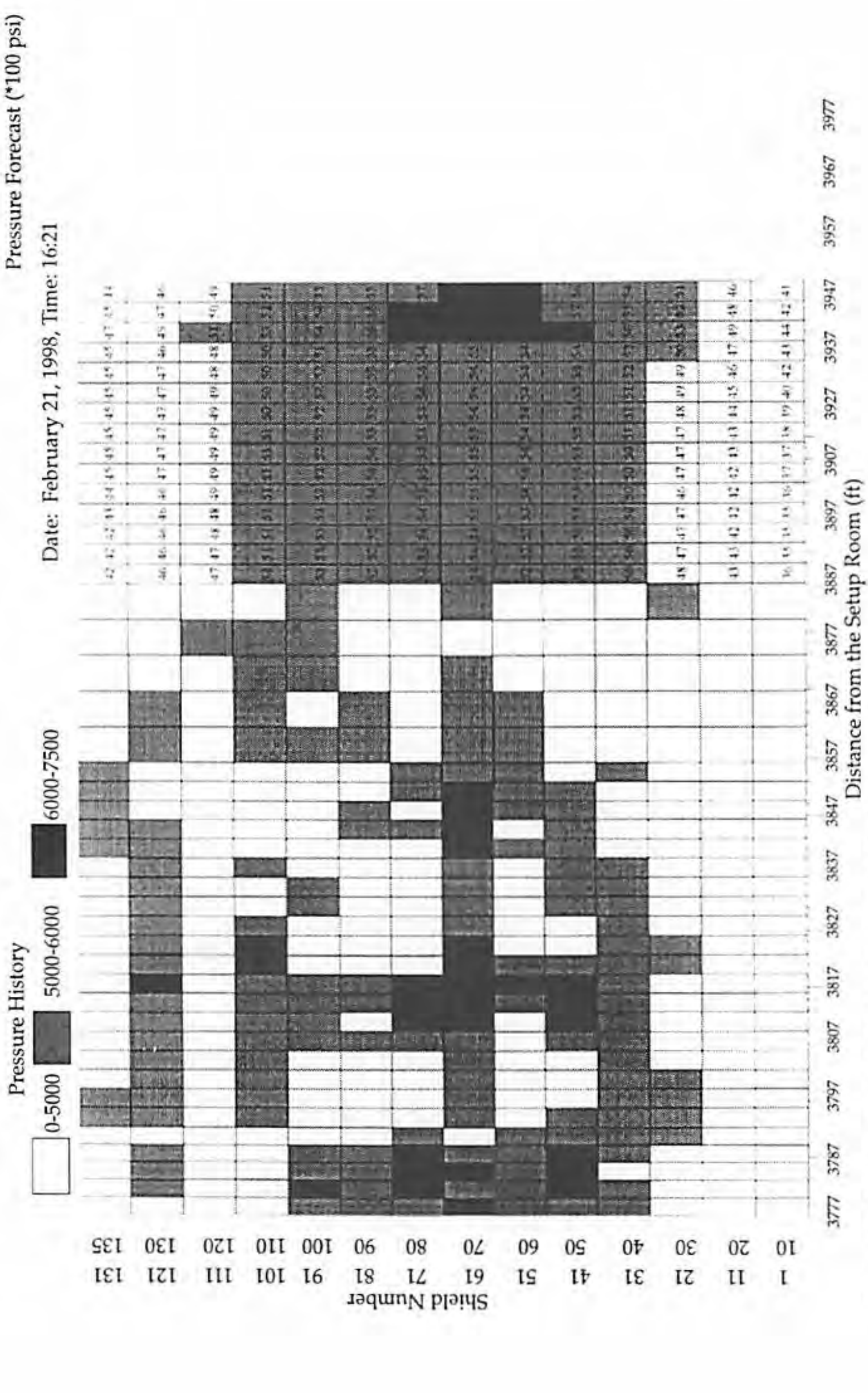

Figure 7. Forecasting of shield pressure of the forthcoming cycles.

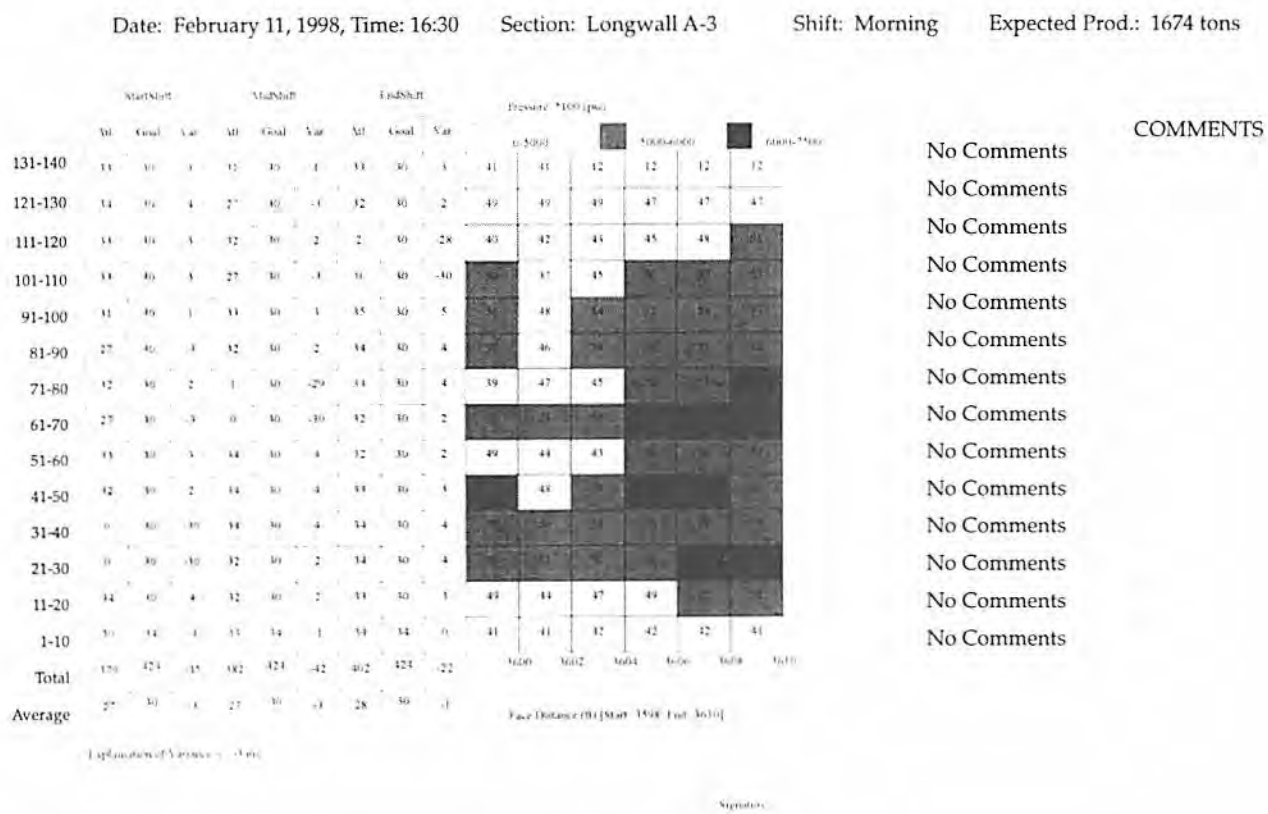

Figure 8. Cutting height and pressure distribution of a shift.

POTENTIAL APPLICATION OF LOSCOMS FOR ILLINOIS MINING INDUSTRIES

In the Illinois coal field, longwall mining is performed at a shallow depth, having a relatively weaker floor and relatively thick coal seam. These geological characteristics may predispose to floor heaving, roof breakage and excessive roof-to-floor convergence, etc. Excessive pressure on the leg may cause the shield base to dip into the weak floor instead of responding to the roof load. As a result, floor heave may occur at the face causing instability of the face conveyor, shearer, etc. This phenomenon may result in high maintenance costs due to longer downtimes and production delays.

Due to the capability of LoSCoMS to analyze shield pressure data and forecast possible instability problems ahead of time, mine management has enough information and time to cope with any unusual events. This system can also help determine secondary supports in the tail entry area. In addition, it can also be used to improve longwall supervision with on-line maintenance information for every shield. LoSCoMS's tremendous power of information generation can be extended into other areas, such as dust control, panel and pillar design, subsidence control, etc.

CONCLUSIONS

Ground control in longwall mining is complex because oftentimes instability such as a roof fall or excessive loading on the shields is difficult to prevent. LoSCoMS monitors shield pressure, transferring data to the surface and analyzes them to determine the roof and floor behavior of longwall panels. Continuous monitoring of shield pressures through LoSCoMS generates real-time data, which can be used to minimize longwall downtimes and maintenance costs by preventing instability problems.

This system not only presents real-time and past shield pressures but also analyzes them to evaluate periodic roof weighting and roof and floor conditions of a longwall face. Unique features of this system include the capability of calculating setting and final pressures and other mining cycle parameters. In addition, the application of the artificial intelligence technique (e.g., neural networks fuzzy sets) to forecast periodic roof weighting and/or shield pressures of forthcoming cycles is an important feature for good mine management. LoSCoMS also provides information about shield maintenance such as leg leakage, faulty transducers, low setting pressure, etc.

With the help of predicted intensities and durations of periodic roof weightings, mine management can make proper decisions about scheduling idle times and regular maintenance. This system also helps management to minimize the cutting of additional out-of-seam material. Thus, LoSCoMS is a practical tool for enhancing coal mine safety, efficiency and productivity.

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Debasis Deb: Are there any questions or comments?

Question: I am a geologist and your method of data collection wasn't very clear to me. Does the software have the ability to distinguish between the magnitude of the compressive stress and the orientation of the compressive stress on the shield? And, also, what are the increments of time for measurement of the compressive stress or the vertical stress?

Debasis Deb: You are getting the shield pressure data from the pressure sensors mounted on every shield leg provided by Joy Manufacturing. So, it is just the hydraulic pressure on that leg.

Question: So, it is sensing the vertical stress?

Debasis Deb: It could be the vertical stress. It is the response of the shield to the roof pressure. This hydraulic pressure on the shield leg is referred to as shield pressure.

Question: How would you be able to use this software in a geologic system such as the Illinois Basin where you got the Cottage Grove Fault System, which is a ridge fault? In this case, the maximum compressive stress is horizontal, two and a half times that of the vertical, and the change of pressure within the fault zone is rather drastic within a few thousand feet. How would this software work within this geological anomaly?

Debasis Deb: We believe that if there is any kind of geologic anomaly or fault, the shield will pick up that information for us. That way, drastic change in the shield pressure can be identified with geologic anomalies, and we will know how the shield behaves under their influence. If there is high horizontal pressure, the shield will respond to that and will be reflected in its pressure. From this, loading patterns can be formulated so that we can identify similar geologic anomalies in the future. In this case, there will be a shield pressure pattern for the geologic anomaly you are referring to, and we look for those patterns; i. e., how the shield is behaving under these geologic anomalies.

Paul Chugh: Maybe I could comment on that. That is a very good question. I think you have got to look at a set of shields rather than one shield because the load is distributed due in part to the geologic anomalies. You've got to look at the pressure distribution over a large area to determine what is really going on—how the shields respond when an anomaly is getting close. Consol is doing some excellent work in this area.

Question: Are you using absolute pressure?

Debasis Deb: We are using absolute pressure.

Question: In looking at the closures. Were you instrumenting closure rates on the shields or just saying that the shield was closed?

Debasis Deb: Yes, they are measured every time from the canopy tip to the pan line tip. So, they are exactly getting how much closure occurs between roof and floor.

Phil Ott: Any other questions? Thank you, Dr. Deb.

The next speaker is Ron Laswell. He is the president of Catlin Coal Company of Terre Haute, Indiana. He is going to talk on "The Effects and Economics of Dehumidifying Mine Air."

Ron Laswell: Good morning. My speech today is not going to be nearly as long as those of the other guys. I just hired my engineer a couple of weeks ago, and the first thing I told him was to keep your priorities straight. It took him four or five days and after the first week, he understood what I said.

Last weekend, a friend of mine called me up and said, "Let's go fishin'." Well, I said, "You know, you gotta keep your priorities straight, and I got a talk next Friday at the coal mining institute in Illinois." He said, "Oh, we'll get you back Thursday night." We took off Saturday and Sunday and went fishin'. We got in last night late. I still didn't have a talk for you this morning; so we are going to do some filling in. I think you'll find that we are doing very interesting work.

The fishin' wasn't that good and it was a dry county. We went through Hope, Arkansas, and there wasn't none there neither. But we did catch 80 or 90 fish.

THE EFFECTS AND ECONOMICS OF DEHUMIDIFYING MINE AIR AT THE RIOLA MINE, VERMILION COUNTY, ILLINOIS

RONALD E. LASWELL

Catlin Coal Company
Terre Haute, Indiana

BACKGROUND

The Riola Mine is a privately held mine located six miles south of Catlin, Illinois, in Vermilion County. It is an underground mine using the room and pillar method. The mine was opened in 1996 after a slope was developed down to the Herrin (No. 6) Coal. The mine employs 60 people and currently produces at a rate of 75,000 clean tons per month.

We mine with two Joy 14-15 continuous miners, four Joy battery-powered haulage units (AH1200), two twin-boom roof bolters and two diesel-powered scoops.

The coal bed averages six feet in thickness; it is about 250 feet deep. Our coal reserve underlies farm ground and no subsidence is planned to occur.

Bedrock was encountered at a depth of 40 to 50 feet; it consists mainly of shales and claystones. These consolidated rock formations have proved to be very tight as no groundwater is present in the mine. Also, no gas has ever been detected in the mine.

The roof immediately above the coal seam is comprised of laminated, gray shale. The floor underclay is up to two feet thick. This underclay is very susceptible to absorbing water. Thus, roof falls from the laminations in the roof shale and poor floor are the mine's two biggest problems.

Air to the mine is supplied using a "push-pull" fan system. An intake shaft was bored and a 70,000 cu ft/min fan installed. A return air shaft was also bored and equipped with a 48,000 cu ft/min fan. These fans provide more than adequate airflow to the mine. As sections are mined out, they are sealed tightly using concrete blocks and mortar.

In 1996, the mine began operation using this system to supply surface air to the mine. This was the same in 1997.

ENCOUNTERING ADVERSE MINING CONDITIONS

In 1997, as the mine grew, we began to see adverse conditions occur in the mine due to roof falls and poor floor. Dealing with these adverse conditions began to occupy more and more of our resources.

It was observed that these conditions were worse in the summer months, but that they went away in winter. The variables of temperature and humidity in the mine air were determined to be at the root of our problems. The mean temperature of the mine air is 58°F. We targeted this temperature for our intake air.

The surface air we blew in was typically 75° to 85°F and in excess of 70 percent humidity. The mine cooled this air, and the moisture condensed on the mine roof, walls and floor. This moisture caused the roof shale laminations to weaken and the floor underclay to become saturated. Therefore, the idea to "air condition" the mine was established. If we could chill the intake air close to the 58°F mine air, then the moisture could be condensed on the surface and not in the mine. The mine would then see conditions that resemble those for the months of January and February.

REMOVING EXCESS HUMIDITY

A trial test to air-condition the intake air was set for 1998. A 200-ton industrial air conditioner, comprised of eight 25-ton compressors with two 35,000 cu ft/min air handlers was leased. These were easily installed on the surface next to the intake fan, in mid-May.

During the first test, the one 200-ton unit proved to be insufficient to cool the intake air more than 15°F. Therefore, a second 200-ton unit was leased and installed in early June. These two units effectively cooled the intake air by 20° to 25°F and the intake air temperature seen in the mine was approximately 62°F. This left only a 4°F difference between the mean mine temperature and the intake air; thus, the potential for condensation was very small.

Routine tests of temperature and humidity in the mine showed that the air temperature dropped only 1°F over 6,600 feet between the intake and the face. At the face, the temperature actually increased from the heat of the mining equipment. The return air showed an increase of 2°F and an increase of humidity of 16 percent. Therefore, this air actually was drying the mine.

RESULTS

Mine conditions were observed to improve. The main benefits were significant reductions in re-bolting of the roof, cleanup of roof falls, and cleanup of soft floor. Overall, the mine productivity has continued to improve almost on a daily basis. As a matter of fact, a new daily production record was set yesterday.

An unexpected side effect has been that the rock dust does not adhere to the walls quite as quickly as before; however, we are perfecting this technique.

We feel the biggest benefit to the mine is in an area we cannot measure easily; this is safety. We have had no accidents related to roof falls in 1998. Future benefits will hopefully be seen in the area of rooms, panels and mains lasting longer and thus extending the mine life by several years.

As we enter the fall season, we will conclude the test and send back our leased air conditioners.

CONCLUSIONS

We have learned several things this year. First and foremost, the concept works! I could not go to mine management tomorrow to propose that we not use air conditioning next year. Our plan is to purchase our own air conditioner for next season, with less tonnage but increased air flow, so that we can get to 58°F.

Ron Laswell: Thank you. The floor is open for questions.

Question: Can you tell me how many cubic feet per minute you are cooling?

Ron Laswell: About 70 to 75 thousand a minute. We got a system in the mine that no one else is using. We are using a push/pull system. We push about 70 to 75 thousand down in the hole and we suck about 45 to 50 thousand out. The remainder we take out the slope haulage ways, the belt lines. We got to have 20 to 25 thousand out there anyway. We found we can ventilate very well with this 70 to 75 thousand cubic feet per minute. We have no problems whatsoever. My son is the production manager, and he says, "You just mine every ventilator you got." We concentrate on doing very, very good stoppage.

Question: Have you seen a reduction in your ventilation requirements? You move the air easier because you have less water in the air.

Ron Laswell: Hadn't noticed that. Hadn't concentrated on it. I would assume it would be easier to move dry air.

Phil Ott: Thanks, Ron. The next speaker is somebody we are all interested in. His name is Jack Moore. He is the chief of the Office of Coal Development and Marketing, Department of Commerce and Community Affairs. He is going to talk on the Illinois Coal Infrastructure Grants Program and give us an update on the program.

Jack Moore: Thank you, Phil and thanks Ron for leaving me with more time than I wanted.

ILLINOIS COAL INFRASTRUCTURE GRANTS PROGRAM-AN UPDATE

JOHN S. MOORE

Illinois Department of Commerce and Community Affairs
Office of Coal Development and Marketing
Springfield, Illinois

INTRODUCTION

DCCA's Office of Coal Development and Marketing (OCDM) provides technical and financial support to the Illinois coal industry. OCDM awards funding for basic research and development on coal and its utilization, as well as commercial-scale demonstration of the most promising coal utilization technologies. Investment within the Illinois energy sector is stimulated through financial incentives provided by some OCDM programs. Education and marketing programs are conducted to develop and convey appropriate messages about the importance of Illinois coal in meeting domestic and international energy needs.

THE ILLINOIS COAL MARKETING CAMPAIGN

In October 1996, Governor Edgar announced a new initiative–the Illinois Coal Marketing Campaign–aimed at increasing domestic and offshore sales of Illinois coal. This new initiative, administered by OCDM, offers many opportunities to improve the marketability of Illinois coal, as well as increase the competitive position of our product. While the Illinois Coal Marketing Campaign had a modest start in its first year, it is now one of OCDM's most effective and far-reaching programs of support for the Illinois coal industry.

The cornerstone of the marketing campaign is the Illinois Coal Infrastructure Program, which encourages coal producers and support industries to reinvest in Illinois. Through this program, businesses are given incentives to improve and expand the coal mining and transportation systems within Illinois. In FY98–the program's second year–OCDM granted $7.8 million for 24 projects aimed at correcting specific infrastructure limitations that prevent the prompt and economic delivery of Illinois coal to domestic and international markets. These grants leveraged more than $38.5 million in infrastructure improvements and expansions across Illinois in FY98 alone.

The Illinois Coal Infrastructure Program exemplifies successful cooperation between the public and private sectors to overcome adversity. Each project, in addition to bringing immediate benefits to the communities and businesses involved in coal mining, lays the groundwork for the long-term recovery and growth of the Illinois coal industry. Notable projects funded thus far include:

Round 1 FY97

- $530,000 to deploy an innovative mining procedure at the Industry Mine using mobile equipment to enter reserve areas that previously were inaccessible. The project extended the mine's life by five years and preserved 169 jobs.

- $250,000 to establish an on-site source of potable water for the Randolph Prep Plant at the Marissa Mine. The project also linked the Village of Baldwin to the Kaskaskia Water District, resulting in substantial savings to the village.

- $100,000 to assist in the design of a rail spur and loadout facility at Elkhart. The added transportation capabilities will allow Turris to produce an additional 2 million tons of coal per year. More than 110 construction and mining jobs will be created.

- $200,000 to add a stoker coal production circuit and relocate a truck loading facility for both steam and stoker coal from the closed Old Ben Mine 26. The project improved the long-term viability of the remaining Old Ben operations in Randolph County.

- $320,000 to build a barge loading dock in Shawneetown to reduce truck transportation distance from the Big Ridge Mine. The resulting lower delivery costs for coal have improved the mine's competitiveness, preserving more than 200 jobs and creating 50 new jobs.

- $200,000 to repair seven miles of track owned by the Kaskaskia Regional Port District and operated by Peabody Coal Co. The track connects Peabody's Randolph Prep Plant to the rail and coal terminal south of New Athens.

- $50,000 to study options for increasing movement of Illinois coal to Mexican markets through the Tri-City Regional Port District.

- $230,000 to study the feasibility of a new power plant at the Captain Mine complex in Perry County. A new power plant at this site plant could result in as much as $600 million in new investments and create or preserve 165 jobs as well as 250 construction jobs.

Round 2 FY98

- $535,000 to modernize and repair the train loadout, rotary breaker and preparation plant facilities at the Brushy Creek Mine in Saline County, increasing efficiency by seven percent. Slated for closure in November 1997 due to lost markets, the Brushy Creek Mine has been able to find new customers, maintain production and improve coal quality as a result of this grant.

- $2,000 to modernize and increase efficiency at the Brushy Creek Mine truck weight station in Saline County.

- $200,000 to develop road access to the newly opened Paum Creek Mine in Jackson County. The success of this mine in its first year of production has shown the potential to foster growth in the coal industry in Illinois.

- $500,000 to preserve railroad right-of-way to the proposed Walker Creek surface mine in Jackson and Perry counties. Had this project not gone forward, the right-of-way would have reverted back to adjacent property owners along the rail line.

- $200,000 to expand the Galatia Mine coal refuse disposal capacity in Saline County. Without the expansion, mine refuse capacity would be exhausted this year.

- $150,000 to install a stoker circuit at the Galatia Mine in Saline County to increase capacity by 300,000 tons, creating 60 jobs.

- $120,000 to add truck loadout facilities at the Galatia Coal Preparation Plant in Saline County.

- $500,000 to purchase additional railroad track to increase the train size and staging area at the Cora Terminal in Randolph County. Efficiency gains could increase Illinois coal movement through Cora by as much as 750,000 tons annually.

- $400,000 for infrastructure improvements to the coal storage and blending facilities at the Cora Terminal in Randolph County to improve handling and blending capabilities.

- $500,000 to construct new intake and exhaust shafts and install a new fan at the Elkhart Mine in Logan County. This project, when completed, will significantly reduce mine-operating costs and extend the life of the mine.

- $60,000 for road improvements to the Turris Mine in Logan County.

- $140,000 to construct an enclosure over the raw coal stockpile at the Marissa Mine complex in Washington County. This project has eliminated environmental problems from coal dust blowing off coal piles at this transfer station.

- $550,000 to build an automated truck loadout facility at its Randolph Prep Plant in Marissa, Washington County. The project adds trucking capabilities to the prep plant, opening the mine to new markets.

- $400,000 to install a truck loadout facility, preparation plant oversight control system and thermal dryer performance enhancements at Rend Lake in Jefferson County. This project improved efficiency and reduced costs of scheduling delays.

- $80,000 for the construction of a coal ground storage system at the Consolidated Grain and Barge Company in Pulaski County. This project provides the capability of blending varieties of coal, improving marketing options for local coal producers and increasing jobs at the facility by 30 percent.

- $250,000 to the Cook Coal Terminal in Massac County to complete rail infrastructure improvements along the mine access track and reduce handling delays.

- $400,000 to improve coal storage and loading capability at the Crown II Mine near Virden in Macoupin County and help preserve 330 jobs.

- $500,000 to purchase rail from the Illinois Central to serve the Walker Creek and Fidelity mines in Perry and Jackson counties. The track will be renovated to provide service for a proposed surface mine in Southern Illinois.

- $280,000 to increase production by 400,000 tons at the Crown III Mine near Farmersville in Macoupin County, and help expand coal handling and loading facilities.

- $100,000 to improve access roads and blending capabilities at the Ohio River Dock in Hardin County.

- $170,000 to upgrade roads serving the Big Ridge Mine in Saline County.

- $300,000 to develop on-site disposal or preparation plant reject at the Pattiki Mine in White County and help protect 230 jobs.

SUMMARY

In several instances, the funds provided to mining operations actually spelled the difference in continuing operation. In a time when cents per ton rather than dollars per ton is crucial to coal sales, every efficiency and technical improvement including transportation must be examined and taken advantage of. OCDM believes that the infrastructure grant program, by providing incentive capital in the form of direct grants to the extraction and transportation aspects of the coal industry, has assisted the industry in remaining viable.

OCDM is now processing requests for a third round of grants. It is our intention to distribute nearly ten million dollars to help this vital industry survive and prosper.

Jack Moore: If there are any questions regarding the infrastructure program, I would be happy to try to answer them.

Phil Ott: Thanks, Jack. I know all the companies appreciate the help and support you have given the last few years.

This ends our second technical session. I want to remind everybody that there is a luncheon, which will start immediately. If you don't have tickets, I'm sure there are still some available. We have a real good speaker.

I want to thank everybody for turning out. I know it has been a difficult year, and we appreciate the people from the mines and the vendors and all the support we have gotten this year. Thank you.

LUNCHEON MEETING

Friday, September 25, 1998
Ballroom A–12:00 Noon

Gregg Bierei: Good afternoon. My name is Gregg Bierei and I would like to welcome you to the 106th annual meeting of the Illinois Mining Institute. Right now, I would like to introduce our head table. On my right, Phil Ott, Freeman, chairman of today's technical session; Malcolm Goodinson, Sales Manager with Huwood International, one of our speaker's today; Paul Chugh, Chairman of the Mining Engineering Department at Southern Illinois University; Ron Morse and his wife DeAnna, Ron is the regional coordinator of IL EPA; and Joe Spivey, President of the Illinois Coal Association. Starting at the other end, we have John Wilson, University of Missouri-Rolla, chairman of the Mining Engineering Department, and he is also chairman of our Scholarship Committee; Darrell Auch, a vice president of Consolidation Coal Company and responsible for Illinois and West Kentucky Operations, also chairman of our Nominating Committee; Jack Moore, Chief, Office of Coal Development and Marketing with IDCCA and was also a speaker today; Andy Blumenfeld, Vice President of Market Research, Arch Coal; Ron Laswell, president of Catlin Coal Company and a speaker here today; Dick Mottershaw, Director of the Office of Mines and Minerals; and Mark Cavinder, IMI president-elect and vice president and general manager of Old Ben Coal Company.

I would like to also thank Phyllis Godwin for all the work she performed here in the past year; she and all the people with the Illinois State Geological Survey who have really helped us out throughout the year on behalf of the IMI.

At this time, we would like to make some presentations. I'd like to ask John Wilson to present our Scholarship awards for this year.

John Wilson: It gives me great pleasure to say that the Illinois Mining Institute awarded $10,000 for scholarships to students at four different institutions. I'd like the representatives of these institutions to come forward when I call them and introduce the students who got the award and present them with a plaque.

First, from Southern Illinois University, Paul Chugh

Paul Chugh: We award our scholarships the year before. [Stewart Adams, Curtis Eichen, Matthew Feist, Mark Noel, Christopher Russell, Howard Thomas, and Brian Vanmiddendorp]. A couple of them had exams this morning. On behalf of them, I would like to thank IMI for your support.

John Wilson: There were actually seven recipients from that school this year.

From the Illinois Eastern Community Colleges, John Arview.

I believe the three students are Tim Wilson, Adam Deal and the third one is Ray Quertermous. [Applause].

Scholarship winners from Illinois Eastern Community Colleges, left to right: Ray Quertermous, Instructor John Arview, Adam Deal and Tim Wilson.

Do we have Harold Finn here from Rend Lake? A representative from Rend Lake?

D. J. Johnson: Harold Finn left the employment of Rend Lake College about three years ago. Our student is Ron Shelton. But I want to thank the Illinois Mining Institute. Right now mining is not all that prosperous. Back in the 70s and 80s we had a lot of men from Rend Lake College who found employment and many of them were successful. It is kind of sweet to see these men and women coming back now to retool for jobs other than mining. But the Illinois Mining Institute has, in good times and bad, had the wisdom to dedicate a portion of the money to some people who will be part of what I believe is the Phoenix or resurrection someday in the future, and I really appreciate that.

Ron Shelton is our recipient from Rend Lake College and hopefully someday he'll be an electrician in the mining industry. Ron. [*Applause*]

Rend Lake scholarship winner Ron Shelton and Instructor D. J. Johnson.

John Wilson: The fourth college is the University of Missouri-Rolla and I would like to ask my colleague Jerry Tien to make the presentations.

Jerry Tien: Can you hear me? I might say I *am* standing; can you see me?

We have four recipients: Michael Droscsz, he is from Crystal Lake, Illinois; Matthew Widman from Highland, Illinois; Erik Palau, a sophomore from Collinsville; and John Aaron Phipps from Chrisman, Illinois. John Phipps came to us as a geologist to become a mine engineer. [Applause]

On behalf of the students and the department, we are grateful to the IMI.

University of Missouri scholarship winners with Prof. Jerry Tien, left to right: Matthew Widman, John Aaron Phipps, Prof. Tien, Erik Palau and Michael Droscsz.

John Wilson: Aaron Phipps is from Purdue. He recognized that UMR is a pretty good place. Thank you very much. That concludes the presentation of the scholarships. Thank you.

Gregg Bierei: The next presentation will be the reclamation and safety awards. Dick Mottershaw will present those awards.

SAFETY, RECLAMATION AND OTHER AWARDS

Richard Mottershaw: We will present the mine safety awards first. The first will be the large underground, small underground, large surface and small surface. I'll ask Sam Vancil to read us the criteria and winners. This award is given yearly to the mines with the best safety frequency by the Office of Mines and Minerals and the Illinois Coal Association. President Spivey would you like to assist in giving out the awards?

Sam Vancil: As Mr. Mottershaw announced, these are annual awards presented by the Illinois Department of Natural Resources, Office of Mines and Minerals and the Illinois Coal Association. These are presented from 22 Illinois coal operations. They are based on the M.S.H.A. report of accident frequency rates. The Division I Underground category includes all underground operations that work more than 500,000 man hours. The

Division I Surface category includes all surface operations that work 300,000 or more man hours.

At this time, we will present these two awards. The travelling trophy award for Division I underground coal mines goes to Monterey Coal Company, Mine No. 1, with 652,532 employee hours with a frequency rate of 3.7.

John Lanzerotte (left) of Monterey Coal accepts Division I underground mine award. Center is Richard Mottershaw and right, Joseph Spivey.

The Division I travelling trophy for the safest surface mine in Illinois goes to Arch of Illinois' Captain Mine, with 360,733 employee hours for a 2.8 frequency rate.

Steve Aaron (center) of Arch Coal accepts the Division I surface mine award. Richard Mottershaw (left) and Joe Spivey (right).

The Division II underground coal award goes to Amax Coal Company's Wabash Mine with 300,443 employee hours and a 5.3 frequency rate.

Division II underground award is accepted by Perry Whitley (left) of Amax Coal Co. Joe Spivey (center) and Richard Mottershaw (right).

The Division II surface group was won by Jader Fuel Company, Mine No. 4, with 156,853 employee hours with a 3.0 frequency rate.

Gary Carr (center) of Jader No. 4, accepts the Division II surface mine award.

The support group award this year was won by Peabody Coal Company's Randolph Prep Plant, with 158,939 employee hours and a 1.3 frequency rate.

Mike Bartelbort (center) accepts award for Randolph Prep Plant. Dick Mottershaw (left) and Joe Spivey (right).

That concludes our safety awards presentation. Now we have some more presentations we would like to make for lifesaving awards.

On May 13, 1998, about an hour and a half into the prep plant's second shift, Turris Coal Company's mine employee Gary Scott became Ill, staggered and fell. Instantly, fellow employee Richard Weaver caught Gary's head and started to protect it from the fall. After laying Gary on his back, Richard used his two-way radio to call the warehouse to request an EMT and an ambulance.

Mike Miller, an EMT working as the shift's top lander, heard the radio transmission and headed to the scene of the emergency. Upon arrival, Mike began the ventilation part of CPR while fellow employee Carl Ladson performed chest compressions. Mike and Carl continued until the paramedics transported Gary to the hospital.

The physicians at the hospital made note that the kind of heart attack Gary suffered usually ends in death, but the quick actions of these employees sustained Gary's life until surgeon's were able to perform lifesaving emergency surgery on him. So, I would ask Richard Weaver, Mike Miller and Carl Ladson to come up and receive their awards.

Turris Coal lifesaving award winners, Mike Miller (left) and Carl Ladson (right) with Dick Mottershaw (center) and Joe Spivey (far right).

We have three more gentlemen working at Turris Coal Company to honor. When a battery-powered scoop struck employee Vince Eric, employee Larry Wilhelm, who was about 30 feet away from the accident scene, immediately yelled at the scoop operator to stop and back up. Fellow employees Jim Brown and Jerry Jones, both EMTs, heard the commotion and ran to the accident scene. We feel that the immediate actions and coordination of activities performed by Jim and Jerry significantly aided in sustaining Vince's life. Their actions included the clearing of Vince's airway and applying oxygen and injury assessment, first aid to facial bleeding, securing a splint to the injured leg and getting Vince out of the mine. Although several people were involved with the successful lifesaving efforts on Vincent, the actions of those first on the scene, Larry Wilhelm, Jim Brown and Jerry Jones, made a difference between life and death. I would ask Larry Wilhelm, Jerry Jones and Jim Brown to come forward to accept their awards.

Turris Coal Co. lifesaving award winners, front row, left to right: Jim Brown, Larry Wilhelm, Dick Mottershaw, Jerry Jones and Joe Spivey.

The last, but certainly not the least, accident that we have an award for happened on July 3, 1998.

The second shift crew at Peabody Marissa Mine began their shift. Herb Arlt was beginning to bolt his first plate, and he was removing the auger from the roof. The auger vent struck him on the side of the skull. Immediately, his buddy Joe Cavatorta checked on him and went for help. Mr. Cavatorta and John Whitmer returned to the scene and began first aid. Mr. Arlt was then placed on a back board for transportation out of the mine. On the way out of the mine, they were met by Ron Kiehnia, mine manager and EMT, who got into the truck and took over primary care of Herb. Mr. Arlt was brought out of the mine and reached the surface just before the ambulance arrived.

The quick effective care which Arlt received from the aforementioned persons contributed greatly to his survival. These people used every means available to them to care for this injured man and promptly got him to the surface where he could receive professional medical treatment. I would ask that Joe Cavatorta, Ron Kiehnia and John Whitmer come forward and receive their awards.

Marissa Mine lifesaving award winners, Joe Cavatorta (left) and Ron Kiehnia (right) with Dick Mottershaw (center) and Joe Spivey (back).

At this time, Mr. Underwood, Land Reclamation Division Manager, is going to present the Land Reclamation Award.

Kim Underwood: Thank you, Sam. Congratulations to the winners from Marissa and Turris for your courageous efforts.

Annually, the Land Reclamation Division at the Office of Mines and Minerals presents an award to the coal company with new innovative techniques that allow for new methods in our efforts to continue to upgrade our reclamation efforts at the mines.

This year we had a coal company that partnered up with the City of Collinsville to create a soil reclamation process using sludge mixed with lime that allowed them to put a process together where they only had to gowith about two feet of topsoil rather than four feet and still meet crop production mandated by the state reclamation act. So, with that, would the people from the Peabody Hurricane Mine please step forward and accept your award.

1998 Reclamation Award winners (left to right): Ben Turner, Grady White and Frank Brazinski of Peabody Coal Co.; Dick Mottershaw and Kim Underwood, right.

IN MEMORY

Gregg Bierei: At this time I would like to recognize those individuals who are members of the IMI that are no longer with us and passed away in the prior year. Clayton F. Slack a longtime IMI member from 1952 to 1994; who had retired from Clues Corporation, had worked for Sahara and Zeigler for many years. Ray Taucher, IMI member since 1961, retired from Consolidation Coal Company in 1986; a long-time very active member of the Advertising Committee member and Honorary Member of IMI. *[In addition, we have learned of the deaths of three long-time, active members Tom Sawyer, President and owner of Tom Sawyer Electric; Nick Andos, President and CEO of Centrifugal and Mechanical Industries; and D. Leo Gilmartin (retired), Peabody Coal Company. Also, Robert A. Houser.]* May we have a few moments of silence for them.

HONORARY MEMBERSHIP AWARD

Gregg Bierei: At this time, I would like to ask Joe Spivey to say a few words about our honorary member this year.

Joe Spivey: Thank you. Ladies and gentlemen, it gives me great pleasure to talk about a person I've known for many years, Ron Morse. He has been accepted into this fine institution, the Illinois Mining Institute's honorary membership. I would like to tell you just a couple of things about Ron if I may.

I will leave out the bad things and tell you the good. Ron has had quite a career. For many years he was in the United States Marine Corps and served a very distinguished period of time there. He came back to his home roots, Harrisburg in Saline County where he was employed in 1969 with Sahara Coal Company. While there, he served many roles. His chief role was as director of health and safety; but he also held many other offices while with that company.

Ron has also been a very active member in this organization. He served on the Executive Committee as well as the Board of Directors, and I am sure Ron is going to continue to be active in this most worthwhile organization. He and his wife DeAnna and their sons still live in the Saline County area, Harrisburg. It gives me great pleasure to offer you Ron Morse, former director of the Department of Mines and Minerals for the state of Illinois and now serving as the director of the Division of EPA in Marion. Ron, welcome.

Ron Morse: I know how these things go, so I'll be brief. You've been here a long time, had your lunch, and you are ready for guys like me to sit down so you can roll up your little ball of twine and go back to your business. It gives me great honor to serve as your honorary member. I have been a member of this Institute for almost 30 years, and it just gives me chills to be standing here with one of my oldest and dearest friends, Joe Spivey. We've been through some good times and bad times together, and we've had a great time trying to make things work in this industry, and I am proud to stand before you.

As you heard from Joe, I've been a state employee for the past eight or nine years, but my real heart and soul is an employee of Sahara Coal Company, a position I held for almost 25 years. They were part of the casualties of the clean air act and are no longer in business. But, in the 60 years that they did operate, Sahara served this Institute well. I went through my 1997 book and looked at the other recipients and some of them are in this room: Minor Pace and Dick Shockley. If I missed somebody I'm sorry; I saw those two when I sat down. To be mentioned in the same breath with Carl Hayden and Paul Halbersleben, Art Bottomley and Walter Lucas, who were all Sahara managers and all past honorary members, just gives me great satisfaction.

I can say from the bottom of my heart that the mining industry is always going to be near and dear to me, and organizations like this Institute are what will make this industry survive, even with the things that are going on in government and the things that are happening in our industry that look kind of bleak. It is the services of vendors and operators and mine people throughout the country that serve organizations like this that will make it solid. And as D.J. said, we're gonna come back. Illinois still has more reserves than anybody in the world, and we are going to come back one of these days and coal will again be King in Illinois, and this Institute will be part of that growth.

Joe and I were visiting over lunch, and it saddens me a little bit to see what has happened in the industry. Years ago in the late 60s and early 70s, you'd go to Springfield to these meetings and there would be 900 or 1,000 people in attendance, and it was just a great time to be part of the industry. But no matter where it goes or how small it becomes, as long as you keep your heart in the right place and as long as you are sincere that you would like to see this industry survive through these difficult times, it will.

My plea to you is don't fail to support this Institute; it is far too important. Again, thank you, Joe. Thank you, members of the Mining Institute and thank you, the nominating committee. Thank you from DeAnna and my family from the bottom of our hearts. I truly am honored.

1998 Honorary Membership Award winner Ron Morse (center) with Joe Spivey (left) and Gregg Bierei (right).

Gregg Bierei: At this time, I would like to re-introduce Andy Blumenfeld. Andy has been with Arch for eleven years. He took a break and worked with RDI in Boulder, Colorado, which is a market research firm. Andy will update us here on the marketing situation in the midwest.

Andy Blumenfeld: Thank you and good afternoon; and thank you very much for inviting me to give this presentation.

I've been to some of the IMI presentations in the past, and this is one of the best state organizations in the country.

ARCH COAL'S PERSPECTIVE ON ILLINOIS COAL

ANDREW D. BLUMENFELD

Arch Coal, Inc.
St. Louis, Missouri

BACKGROUND

About Arch Coal

I was asked to prepare a presentation about Arch Coal's views on the prospect for coal mining in Illinois. However, before I do that, I want to discuss a little about Arch Coal because we have dramatically changed over the past two years and have grown four-fold from my predecessor company, Arch Mineral.

In brief, Arch Coal is now the second largest coal producer in the U.S. as of June 1 of this year; this is when we completed the acquisition of ARCO Coal and their portfolio of western mines. On a pro-forma basis, Arch produced about 110 million tons with revenues exceeding $1.7 billion. Arch now has a comfortable reserve base of over 3.4 billion tons, not including the recent award of the over 400 million ton reserve in the PRB known as Thundercloud. As the name suggests, we are a St. Louis company. Our stock is publicly traded on the New York Stock Exchange under the symbol ACI.

National Presence

Arch now has a "national" presence. We have a large grouping of both high-volume surface mines and underground mines in the East. This was primarily the net result of the combination of Arch Mineral and Ashland Coal in 1996. Then there is the venerable Arch of Illinois, known better under its traditional moniker-Captain Mine. And in the West, we have Arch of Wyoming in the Hanna Basin and the former ARCO mines: Black Thunder and Coal Creek in the Powder River Basin (PRB), West Elk in Colorado, and the Canyon Fuel mines in Utah. Canyon Fuel is a joint venture between Arch Coal (65 percent) and Itochu of Japan (35 percent).

Arch believes that our national scope will enable the company to stand out because of our enormous flexibility and negotiating strength. We are now capable of doing things that could not have been done historically, e.g., offer blended products and make seasonal sales. This includes working with utilities to enable them to, hopefully, use more Illinois coal.

Arch is fairly evenly split in terms of production capability-east and west (table 1). The focus is on lower sulfur coal because of the Clean Air Act Amendments of 1990 (specifically Title IV).

Table 1. Production in1997 by region.

Region	Million tons
Central Appalachia	41.3
Powder River Basin	40.6
Western Bituminous	18.4
Illinois Basin	4.9
Total	105.2

Arch Coal has retained its Illinois position because of its good sales position and historical significance to the company. It is a low-cost operation with good reserves and excellent transportation access. However, I must caution that Arch's position is rather fluid, and I cannot say, with any certainty, what the future is for any Arch operation.

With the acquisition of ARCO Coal this year, Arch now sells coal coast to coast. We even own parts of two ocean ports: one on the Atlantic at Dominion Terminal Associates in Newport News and the other on the Pacific at Los Angeles Export Terminal.

Arch exports to ten countries overseas and markets coal to steel producers as well as industrial coal consumers.

CONSOLIDATION AND DEREGULATION

I could not very well discuss the situation in Illinois without spending some time on general industry trends, specifically consolidation. Consolidation is happening across all sectors of energy production: utilities, railroads (in fact, all transportation), and the coal producers.

Utility Consolidation

Utility consolidation is just beginning. It is more than consolidation, more akin to reorganization. Utilities are moving from regulated monopolies to fully competitive industries with little or no "regulatory" barriers to entry. Utilities represent a $212 billion industry.

Utility deregulation, as it is better known, will lead to intense competition that will, in turn, lead to lower prices. Lower prices should lead to additional consumption. Because coal is the lowest cost fuel used for electricity generation, we believe there will be a net benefit for coal, especially because there is still a healthy amount of under-utilized, coal-fired capacity in the U.S. and, interestingly, at plants that have used Illinois Basin coal. Increasing the utilization at these plants will mean as much as an additional 150 million tons of annual consumption.

Consolidation in the electric utilities industry is just beginning. As the landscape develops, it will be difficult to keep up with all the announcements. There is much room for consolidation in the utility industry. Over six thousand individual entities are involved; it is very fragmented (table

2). There are economies of scale that can be realized through consolidation; this is why it will happen. Companies will "specialize" based on their strengths; e.g., generation, transmission, distribution, and trading. We are seeing the beginning already. Along with this consolidation will come considerable changes in how utilities purchase coal. We are already feeling the effects of this today.

Table 2. Utility industry in the U.S.

	Number of entities	Number of power plants	Total MW
Investor-owned	210	1,946	551,396
Municipal systems	1,874	906	44,122
Rural electric coops	929	218	34,736
Fed/state/district systems	3,307	428	110,940
Non-utility generators	129	649	44,098
Totals	6,449	4,147	785,292

Source: 1998 Electrical World Directory of Electric Power Producers, McGraw Hill

Railroads Finishing Consolidation

Where the utilities are embarking on consolidation, the railroads are finishing. I do not believe there will be any more announcements, especially for a trans-continental system, during the foreseeable future. The Union Pacific/SouthernPacific difficulties and the current long-term divestiture of Conrail will make further large-scale consolidation difficult.

What we are left with are four major coal-hauling railroads–the CSX, Norfolk Southern, Burlington and Sante Fe, and the Union Pacific. Of course, there is the Illinois Central (to be purchased by the Canadian National) and the Wisconsin Central, but I argue that they are more niche systems with regards to coal. Interestingly, Illinois can enjoy the fact that it rests in the crossroads, able to originate on all major carriers. This is one of the reasons that there is some promise for coal production here.

Consolidation in Coal Mining Industry

Like the utilities and transportation providers, the coal industry has undergone tremendous consolidation. There are some obvious and not so obvious reasons to consolidate. Some of the catalysts are: coal production is a highly competitive industry for which there are winners and losers; those companies where coal is not the primary focus have found it rough going in this industry (look at the number of petroleum companies that have sold or will sell their position in coal–Mobil, British Petroleum, Shell, Exxon (except Monterey and Colombia), Diamond Shamrock, ARCO, and soon Chevron); and other companies did not invest in new reserves or decided it was just too rough.

Because of the expiration of most of the "oil-crisis era" contracts that had escalated to levels well above the current spot market prices, many companies lost the cash flow these provided and were not able to survive at today's prices. Utility deregulation and its intense focus on cost cutting will undoubtedly force lower coal prices, and producers at the high end of the cost curve will not be able to survive.

Then there are the economies of scale — "bigger is better." This is a logical progression for this industry, especially considering the high capital requirements needed for project development. The regulatory climate is also becoming increasingly more complex. More requirements by state and federal agencies for labor, reclamation, financing, and the environment are being imposed. This all adds costs, and when you are bigger, you can spread those costs more efficiently. Finally, bigger does provide more leverage; considering the consolidation of most of our customers, coal producers must follow suit to stay in step. Consolidation has been going at a stellar pace. Even more remarkable has been the level of consolidation during the past five months (table 3). About a third of the industry has changed ownership in less than half a year, the largest being Arch/ARCO, Lehman/Peabody, and Addington/Zeigler and others. Pittsburg & Midway has also announced that they are seeking new ownership, and I believe there is more to come.

Table 3. Mergers and acquisitions-announced transactions (>$40 mm) since 1/1/97.

Date	Buyer	Seller	Price (million $)
3/97	Kennecott	Drummond (Caballo Rojo)	99
3/97	Renco/Lodestar	Costain Coal	45
7/97	Arch Coal	Ashland Coal/Arch Mineral	457
5/98	James River	Blue Diamond	57
5/98	Lehman Bros.	Peabody Coal	2,300
6/98	Arch Coal	ARCO Coal	1,140
6/98	American Coal	Kerr McGee (Galatia Mine)	200
6/98	AEI Resources	Cyprus Amax (eastern mines)	300
7/98	Kennecott	Kerr McGee (Jacob's Ranch)	400
9/98	AEI Resources	Zeigler Coal	855
9/98	Consol	Rochester & Pittsburgh	150

Figure 1 demonstrates that over the course of ten years, the industry has changed dramatically. In 1987, the top ten producers controlled about a third of the industry; in 1997, over two thirds of the production was controlled by the top ten. Many names are now gone, including AMAX, NERCO, ARCO, Old Ben, and others. They became part of larger entities. New names appeared, like AEI, Arch, Kennecott (a rebirth of sorts).

What we are left with are very few "non-coal companies," companies where coal is not their primary source of income. Those that remain are either contemplating exit (P&M) or are expecting improved results. Financial buyers, like Lehman and the Beacon Group, are exceptions. They emphasize the strong cash flow inherent with coal companies. Are they in for the long haul? Good question.

Most coal firms are now privately held. Arch is an exception. We believe, however, that there will be more publicly held coal companies in the future. This relates back to the financial buyers.

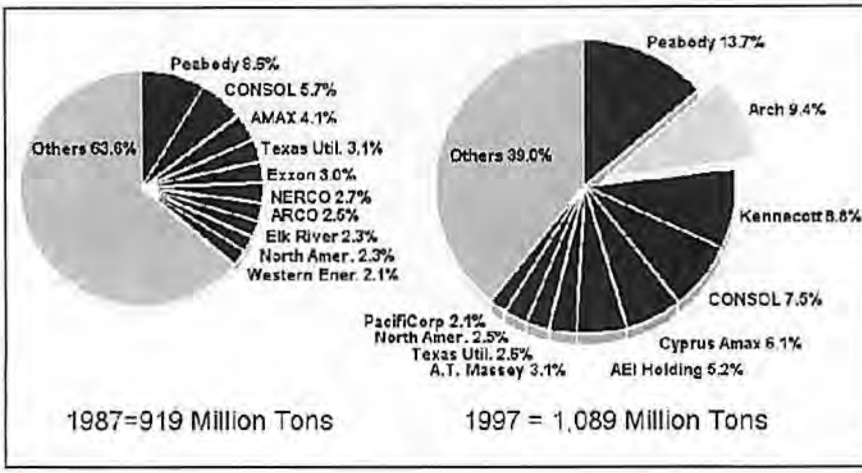

Figure 1. The top ten companies in coal production on a pro forma basis, 1987 and 1997.

For Arch, the experience is beginning to pay off. Size is important in a consolidating industry. As mentioned previously, we now have sourcing flexibility and other options we can now bring to our customers. Size gives us a certain amount of leverage in terms of transportation, materials, and other cost inputs. Obviously, Arch has to lower general and administrative costs on a per ton basis. We can take advantage of volume discounts, lower insurance costs and, with a stronger balance sheet, lower financing costs.

IMPACT OF CLEAN AIR ACT AMENDMENTS

The 1990 Clean Air Act Amendments have played havoc with Illinois coal. Figure 2 shows that the growth in production has been in the lowest sulfur coal, as represented by coal with less than 1.2 $LbSO_2$/mmBtu. In 1989, about 260 million tons of the lowest sulfur coal were sold; in 1998, over 420 million tons are expected to be sold. Most of the lowest sulfur coal is produced in the Powder River Basin. The highest sulfur coal (with an average $S0_2$ content > 2.5 $LbSO_2$/mmBtu) has declined from about 270 million tons in 1989 to 220 million tons expected for this year.

As we approach the implementation of Phase II of the Clean Air Act Amendments on 1/1/2000, there will be further incentive to purchase lower sulfur coal as all coal-fired plants (>75 MW) will "monitize" sulfur. This is, of course, not good news for Illinois.

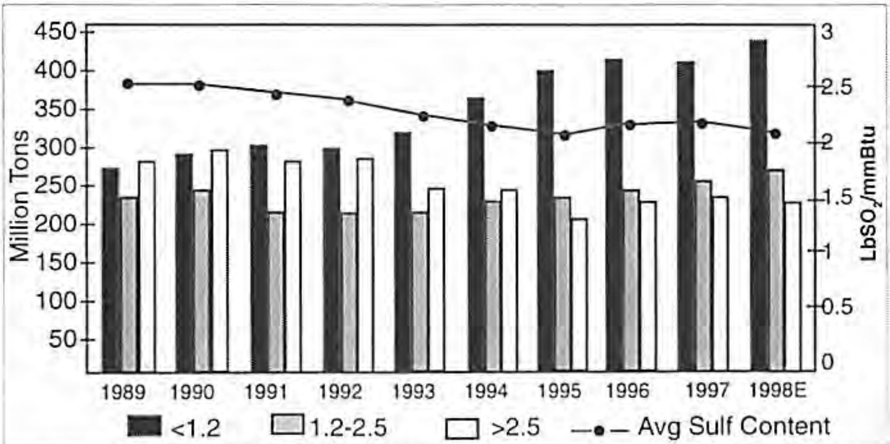

Figure 2. U.S. coal production by sulfur content, 1989-1998.

The national trend of declining high-sulfur sales has affected Illinois more than any other state. High sulfur sales exceeded 47 million tons in 1991; this year, they are expected to be about 22 million tons. Here, the highest sulfur coal is represented in figure 3 by coal containing > 3.0LbSO_2/mmBtu. The good news has been for the lower sulfur coal sales, like that coming from Galatia, Rend Lake, Riola, and Knighthawk. Lower sulfur sales have increased and now account for about one-third of Illinois sales.

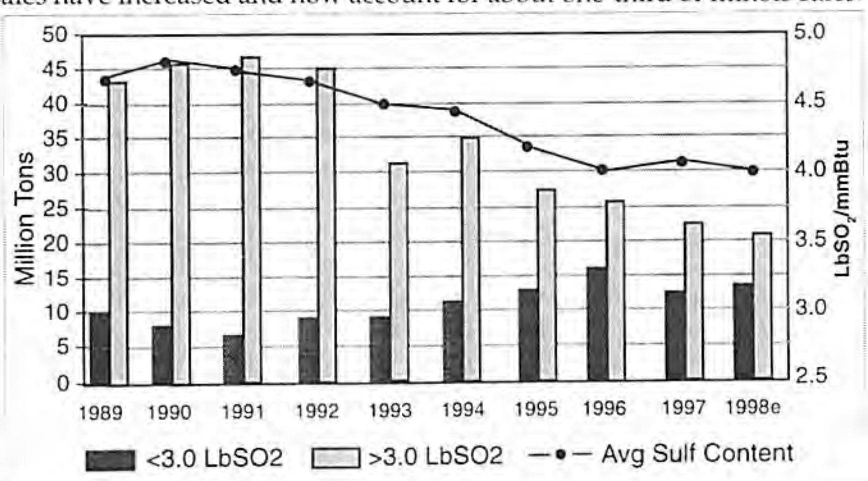

Figure 3. Average SO_2 of Illinois utility coal sales, 1989-1998.

ILLINOIS MARKETS AND PRODUCERS

The largest utility consumers of Illinois coal have been Illinois Power, followed by Ameren (CIPS and UE), Tampa Electric, TVA, and NIPSCO (table 4). Tampa, and NIPSCO are fairly secure because these are scrubbed units. Tampa has announced that they are installing additional scrubbers at Big Bend, and Illinois is a likely candidate to supply coal to those units.

The largest producers (based on last year's production) are CONSOL, AEI (Zeigler) Robert Murray (Galatia), Arch, and Freeman United. As you know, this list will change again next year as some major mines have closed and/or changed ownership.

Table 4. The 1997 top 10 Illinois markets and producers.

Utility	Tons (000s)	% Share	Mine Company	Tons (000s)	% Share
Illinois Power	6,345	18	CONSOL	5,203	13
Ameren (CIPS & UE)	4,680	13	AEI Holdings	5,065	12
Tampa Electric	3,123	9	Robert Murray	4,962	12
TVA	2,761	8	Arch Coal	4,914	12
NIPSCO	2,617	7	Freeman United	4,403	11
CILCO	2,429	7	Peabody	3,995	10
PSI	2,099	6	Exxon	2,923	7
Seminole Electric	1,537	4	MAPCO	2,009	5
Gulf Power	1,354	4	Cyprus Amax	1,607	4
Springfield, IL.	1,195	3	Sugar Camp	1,560	4
Others	7,068	20	Others	4,257	10
Total	35,207		Total	40,899	

History of Illinois Coal Production

I cannot do justice regarding Illinois without covering a little of the history of coal production. Illinois enjoys a diverse transportation network. All the major rail carriers have access to coal in this state, and the two largest river systems border this state.

In 1969, Illinois State Implementation Plans included a limit on SO_2 emissions from stations near the large population areas, namely Chicago and Peoria. The net effect of this was for Illinois coal producers to seek markets beyond Illinois borders. This includes markets in Georgia, Florida, Iowa, and other states. Illinois producers were rather successful, considering the circumstances.

Over half of Illinois sales occur outside the state, compared to western Kentucky and Indiana where most of the sales occur within the producing state (fig. 4). Indiana has the fortune of being a little farther east and not so accessible by western railroads; thus, the in-state producers are a little more "insulated" from western incursion. In addition, the coal being produced there has a lower sulfur content that, along with some scrubbing and allowance purchasing, puts the local producers in a better position. In western Kentucky, a considerable number of scrubbed power plants are operated by LG&E, Big Rivers and TVA, providing a reasonable market for many years.

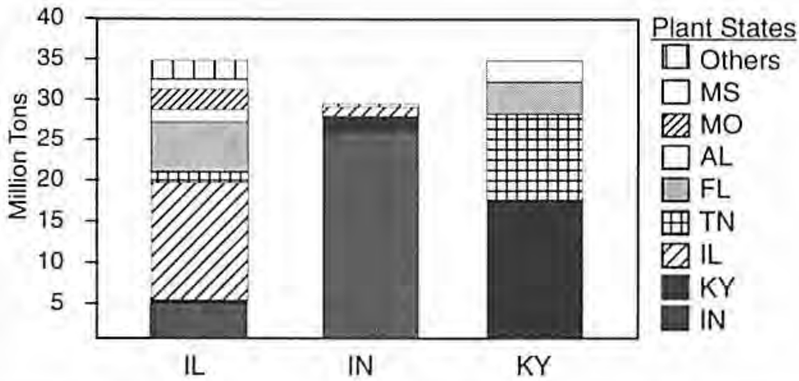

Figure 4. 1997 Illinois basin coal deliveries.

This sets the stage for what is happening today. While Indiana and western Kentucky have somewhat of an advantage in that the delivered cost of the indigenous coal is lower than coal originating from out-of-state, Illinois customers can receive cheaper western coal as a substitute for their Illinois purchases. The "penalty" assessed on Illinois coal by the 1990 Clean Air Act Amendments is enough to cause a severe switch to alternate supplies because the base economics have now changed.

The next result is that the market diversity enjoyed by Illinois producers has turned into a liability, and with a minimal in-state market, the situation becomes most onerous. Far-flung customers are seeking coal from the west and the Appalachian regions. Because Illinois is situated at the eastern terminus of the large western railroads, the state becomes a natural market for that product. And, of course, the Clean Air Act Amendments have penalized Illinois' high sulfur coal.

Illinois producers have suffered the most in the wake of the Clean Air Act Amendments, and I am afraid we have not seen the bottom yet. Coal production had remained fairly stable through 1991; then the decline began. Today, Illinois coal production is just about 35 million tons (fig. 5), a little more than half of what it was just seven years ago. Western Kentucky has also seen a decrease, but not nearly as severe. Indiana, in contrast, has seen an increase in production — nearly all from low-sulfur reserves and most of it by one company.

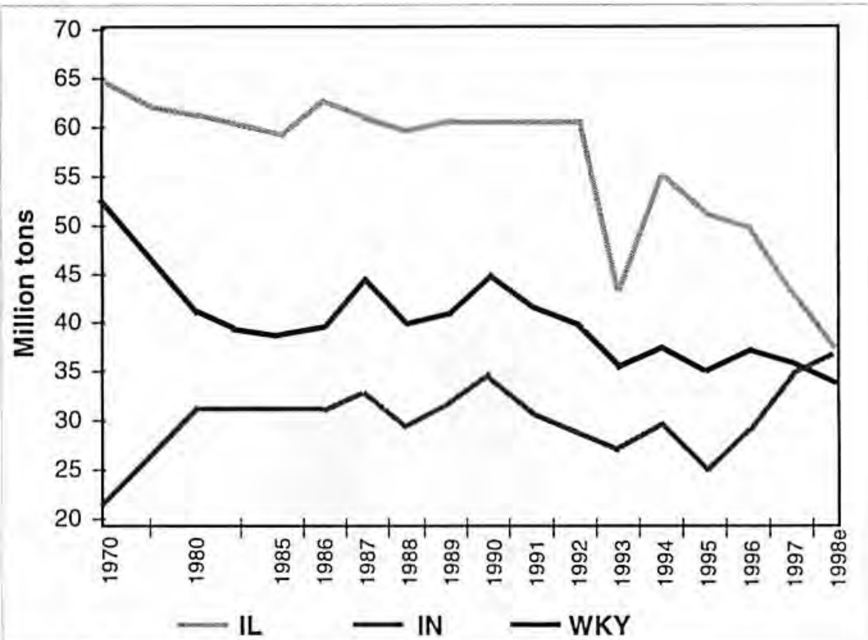

Figure 5. Historical Illinois basin coal production by state.

Illinois Coal Distribution

The distribution of Illinois coal has also suffered. Figure 6 shows the net effect since 1989. The remaining market is now fragmented to really only a handful of utilities. Missouri and Georgia have had the greatest reductions in Illinois coal consumption — and these states probably will not use any Illinois coal beyond 2000. Missouri utilities used to consume well over 10 million tons and now that market is being served by western sources. Florida, as previously mentioned, could increase consumption with the new scrubbers at Tampa's Big Bend. This makes Florida critical to Illinois' future.

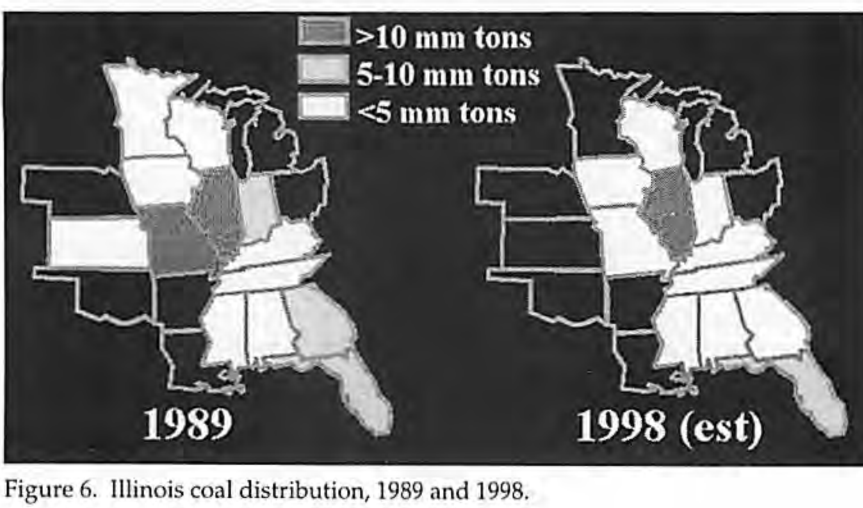

Figure 6. Illinois coal distribution, 1989 and 1998.

Western Coal Intrusion

Figure 7 shows how western coal has intruded into Illinois utility markets. The plants evaluated here all used some Illinois coal since 1989. This graph illustrates the coal purchases by source region for that population of power plants. Overall, this group increased it's coal use as a direct result of generation growth. But growth in coal use came primarily from the PRB, followed by Appalachia, for both economic and environmental reasons.

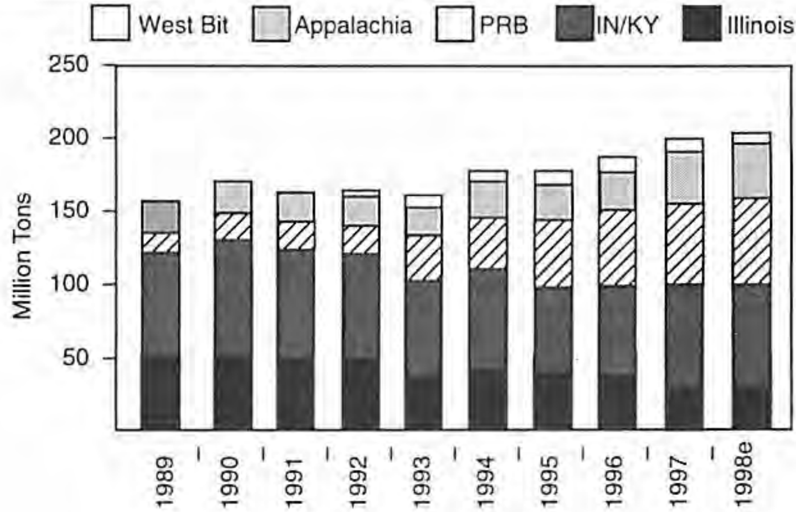

Figure 7. Western coal intrusion in Illinois utility markets.

ARCH'S VIEW ON ILLINOIS' COAL FUTURE

Arch believes that in the next five years it is going to get tougher for Illinois coal as Phase II of the Clean Air Act takes hold on 1/1/2000. The lack of new scrubbers within Illinois or it's neighboring states translates into use of even more western coal. However, there is a little room for optimism for the long term. Proposed environmental regulations, namely on particulates, essentially mandate scrubbing. In addition, as the price for emission allowances increases (fig. 8.), the economics for scrubbing become more favorable. There is also the New Source Performance Standards provision in the original Clean Air Act that basically says that any new unit must have the best available control technology, and most believe that means scrubbers or other technology that would not discriminate based on the sulfur content of the inbound coal. Finally, there are still ample economically recoverable reserves in Illinois.

Higher SO_2 allowance prices will make scrubbing more economical. Interestingly, following the EPA allowance auction in early spring this year, prices moved from about $105 per allowance to about $200 per allowance by late summer. Prices have remained high, averaging close to $180; this might be the beginning of a trend that could lead to more decisions to install scrubbers. If prices move over $200 per allowance, I expect to hear more announcements like that at Tampa; however, I do not see anything on the horizon that would push allowance prices up significantly at this time. As we move into Phase II, this could change.

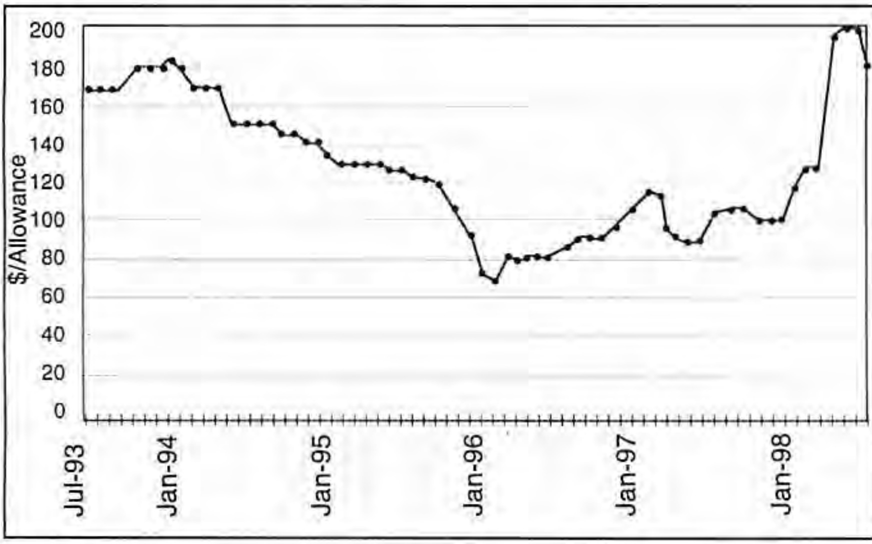

Figure 8. SO_2 emission allow prices, 7/1/93 through 9/1/98.

Enviromental Regulations

Enviromental Regulations are generally unfavorable to coal. The Clean Air Act Amendments have already had a profound impact on Illinois. NOx regulations will not provide any impetus to burn Illinois coal; reductions will have to come from technology fixes, like low NOx burners and select catalytic reduction.

Regulations for Particulates and Hazardous Air Pollutants could translate into more scrubbing. Under the public health mandate, the EPA appears to have full authority to impose new regulations that limit emission of particulates. The so-called 2.5 micron limit excludes most filter technologies because the very small particulates are caused by sulfites, and emissions of sulfites can only be removed through scrubbing.

On top of all these regulations looms the proposed climate change treaty, also known as the Kyoto Protocol. This will have no benefit for Illinois coal producers. Rather, it will cause a severe reduction in the use of coal across all regions. I do not believe that the current proposal will get the approval of Congress. However, this does not preclude that there will be a compromise bill that could be approved. It is too early to tell what will happen.

New Coal-fired Power Plants

Some new coal-fired plants are being planned today, and some of these could use Illinois coal. Southern Indiana Gas and Electric is discussing a new station that will use circulating fluidized bed combustion. It is a small, experimental unit. East Kentucky Power and Kentucky Pioneer are also discussing new stations. Tractebel and TVA are building a new CFB unit in Mississippi; however, this plant will use local lignite. Lakeland is also planning for a new combined cycle (coal gasification) CFB unit in Florida.

Table 5. Announced new coal-fired generation.

Utility	Type	Coal Type	Size (MW)	State	Estimated Completion
SIGECO	CFB	Bituminous	42	IN	Unknown
E. Kentucky Power	Unkn	Bituminous	Unkn	KY	Unknown
KY Pioneer Energy	Unkn	Bituminous	Unkn	KY	Unknown
Tractebel/TVA	CFB	Lignite	440	MS	2000
Lakeland	CC/CFB	Bituminous	238	FL	2003

Forecasts

According to two consulting firms (Hill & Associates and Resource Data International) and the Department of Energy, Illinois coal production will suffer in the short-term. Opinion is far from unanimous, though (fig. 9). Arch does not subscribe to any of these predictions for the long-term.

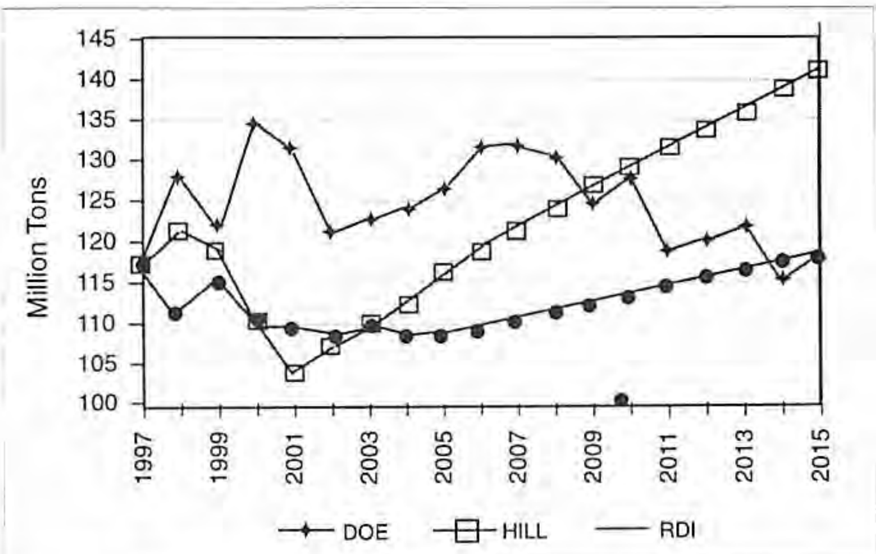

Figure 9. Illinois basin production forecasts to 2015.

Gregg Bierei: Thank you, Andy. We appreciate your insight regarding the future marketing conditions in the Illinois Basin. I would now like to turn over the meeting to our new president, Mark Cavinder.

Mark Cavinder: I have the pleasure of presenting the souvenir gavel to our President, Gregg Bierei. Join me in showing our appreciation to him for a wonderful year as President of IMI. [*Applause*]

President Elect Mark Cavinder presents souvenir gavel to outgoing President Gregg Bierei.

Gregg Bierei: Again, I would like to thank Heinz Damberger for his dedication and commitment to the Illinois Mining Institute. He has been the motivation and driving force behind the Institute. His countless hours of support have kept the organization viable throughout some difficult times. He deserves our many thanks. Let's stand and give Heinz a round of applause. Thank you, Heinz. [*Applause*]

Heinz bids farewell to the IMI.

Heinz Damberger: Thank you. I enjoyed the 20 years as your Secretary-Treasurer, but there must be an end to everything. I plan to retire from the Geological Survey in a good year from now and thought it would be better to pass this job on to somebody else so we can have a smooth transition. I am sure Paul Chugh will serve you well as the new Secretary-Treasurer and bring in some new ideas; times are tough, and we need to be creative. Thanks again for all the help over the years and for the many friendships I made through the IMI!

Gregg Bierei: Now it is time to draw raffle tickets for the two airline tickets to anywhere in the continuous United States and a set of premier golf clubs.

I'd like to call on Kay Winters to draw the tickets for us. The first will be for the trip for two. *[Kris Strothman of Kennametal won the airline tickets]*. The second is for the set of golf clubs *[Mike Laffey of Laffey Equipment won the golf clubs]*.

With that, the 106th annual meeting of the Illinois Mining Institute is adjourned. Thank you all for coming and participating. Have a safe trip home.

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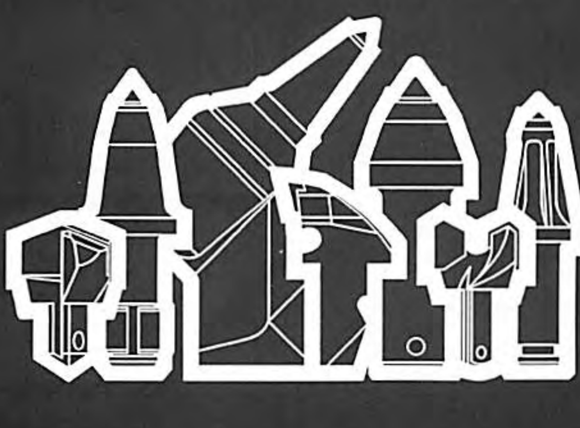

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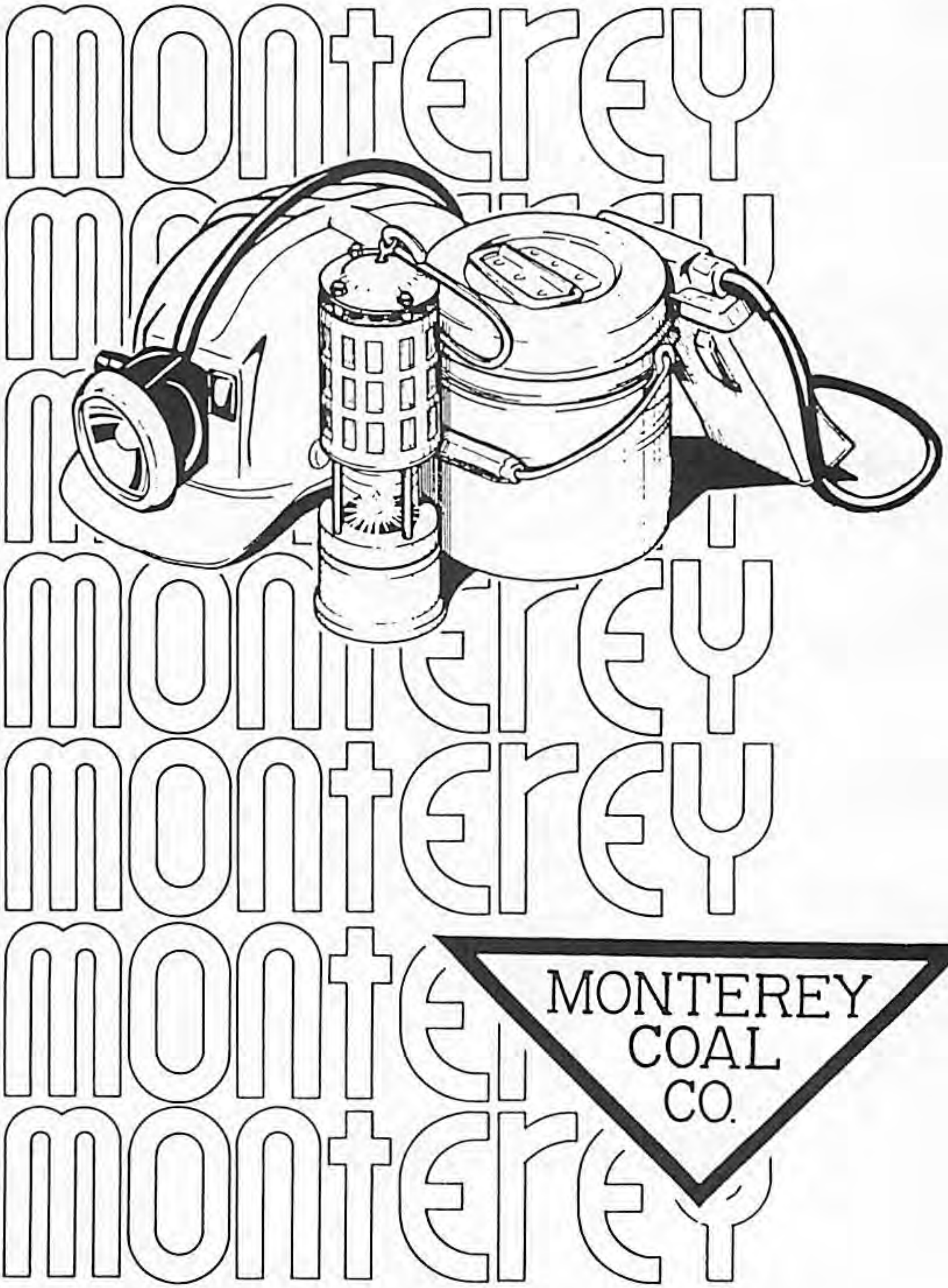
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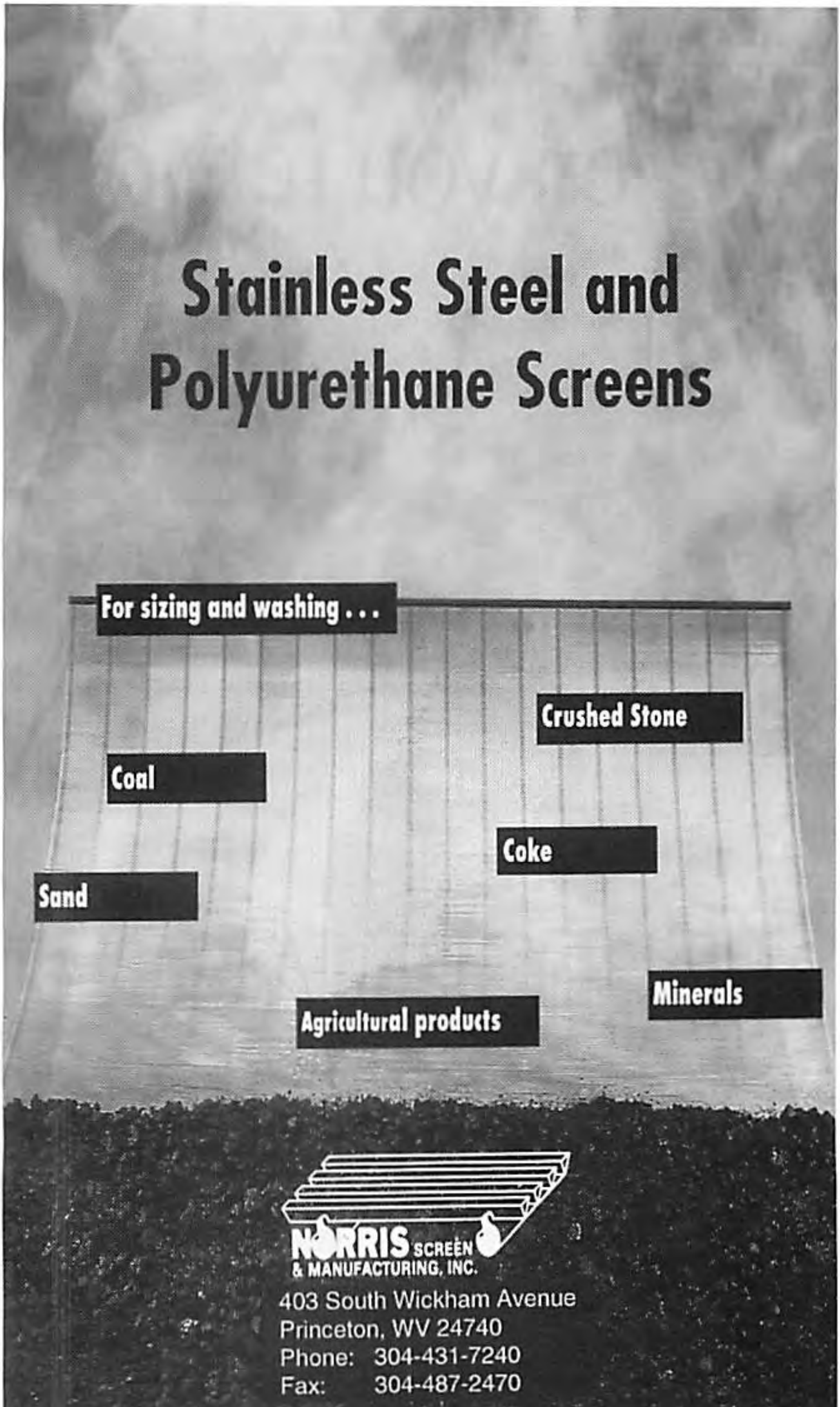
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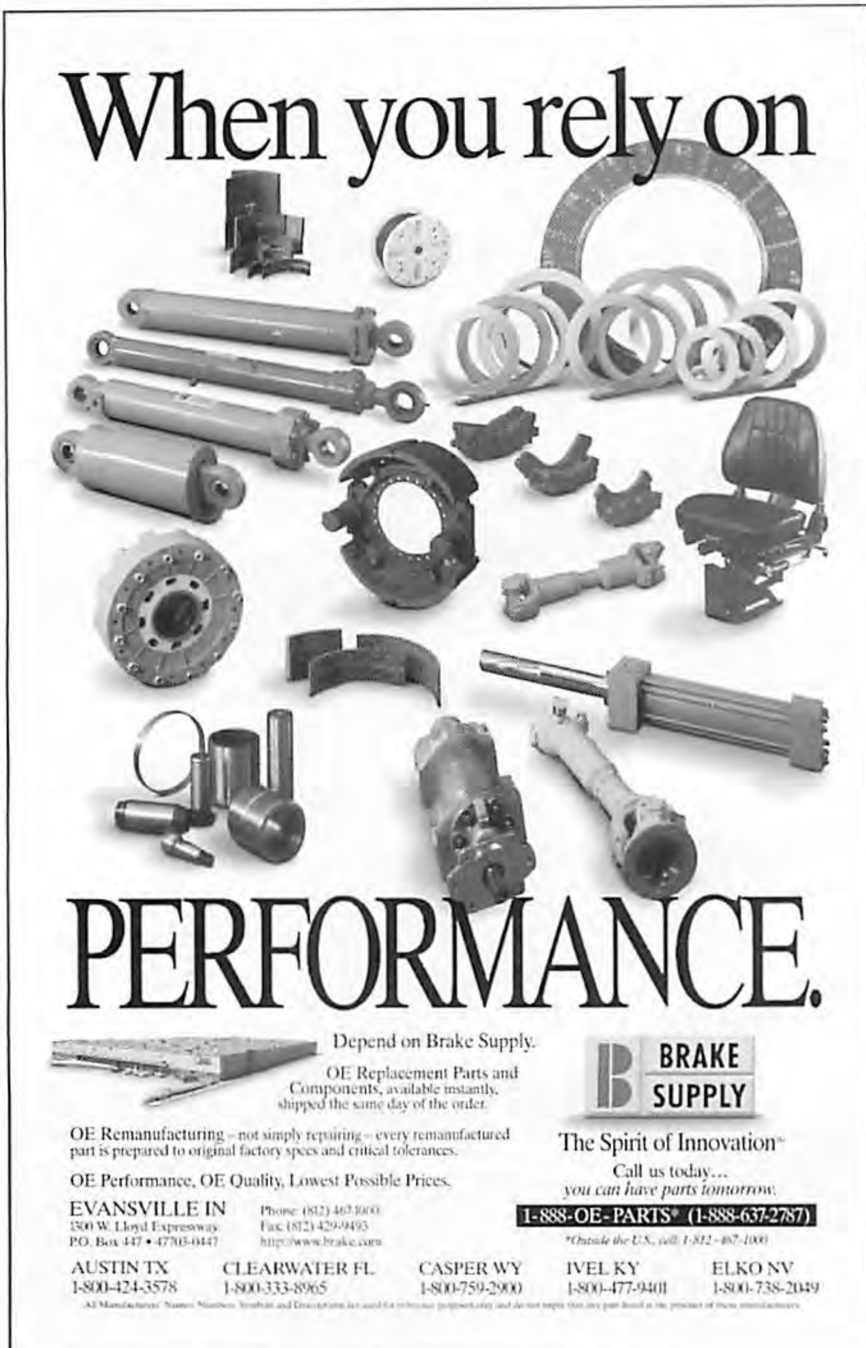
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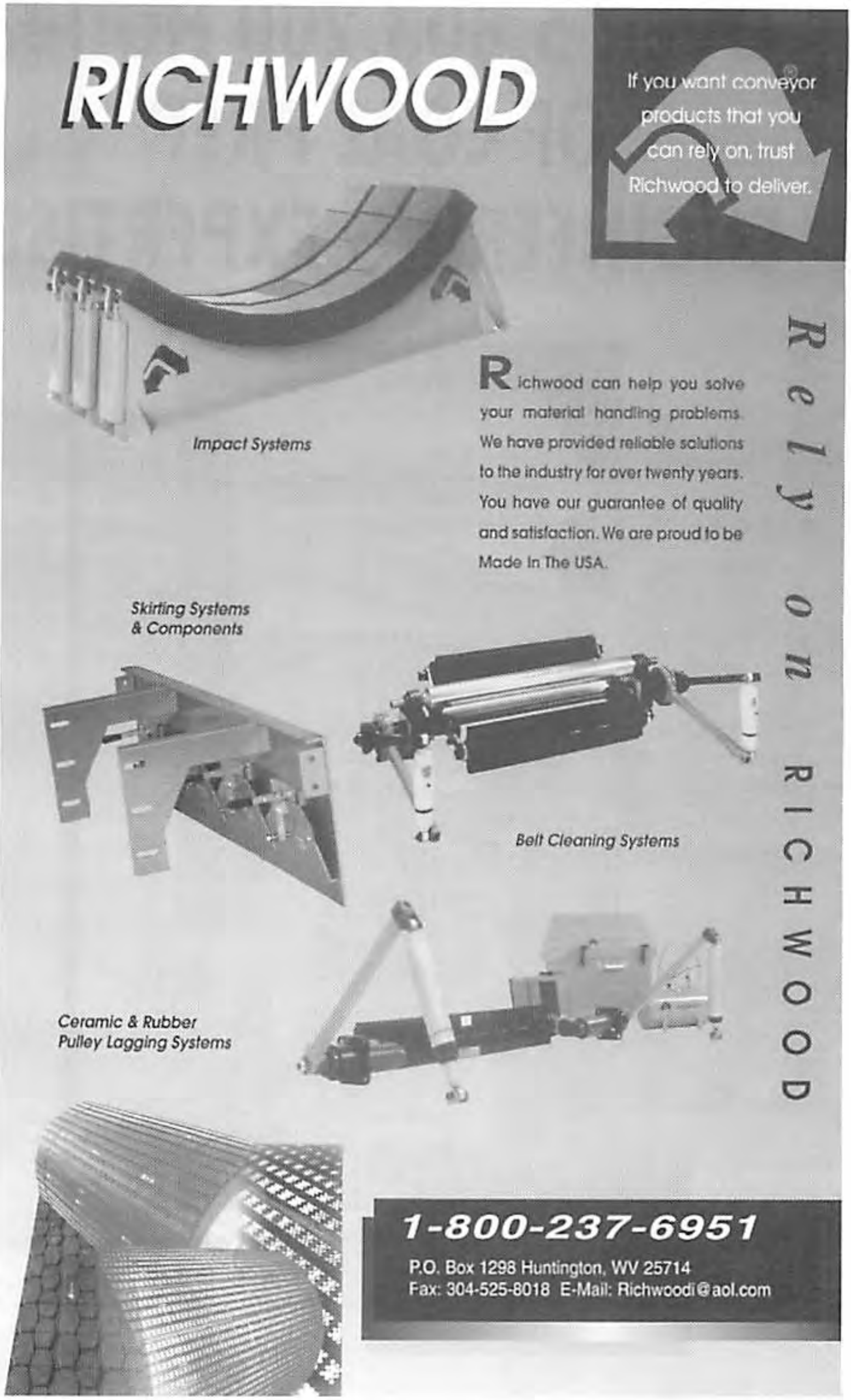
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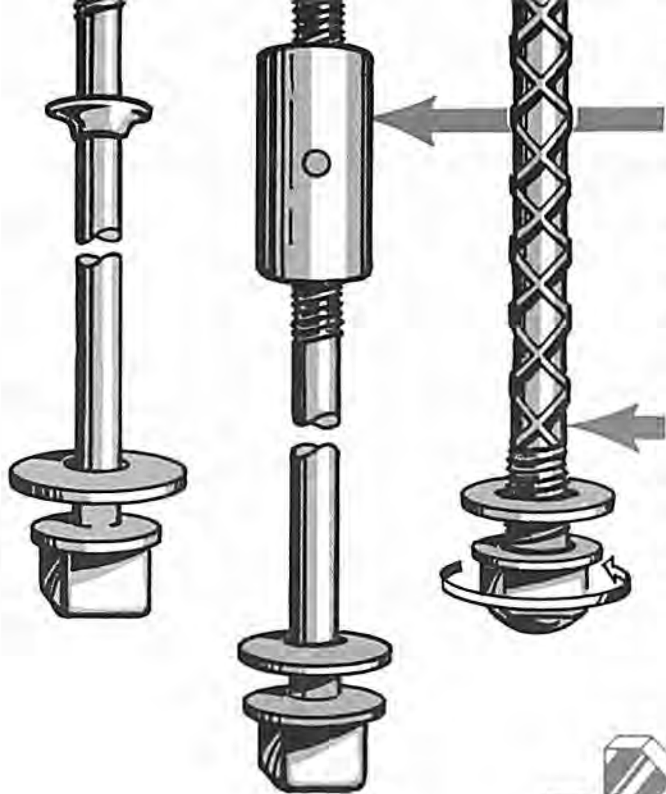

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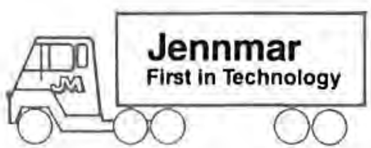

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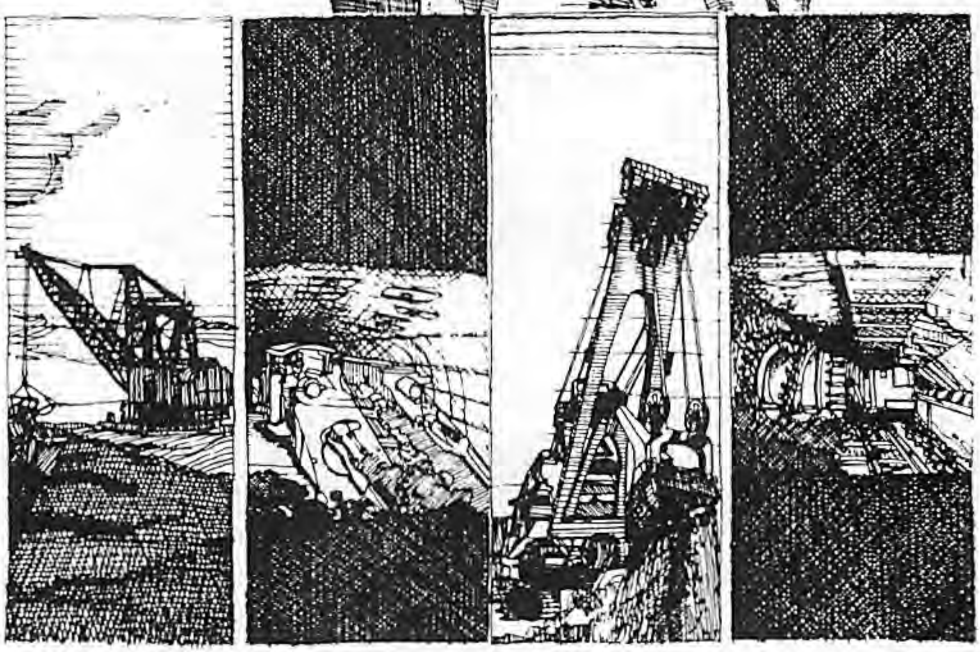

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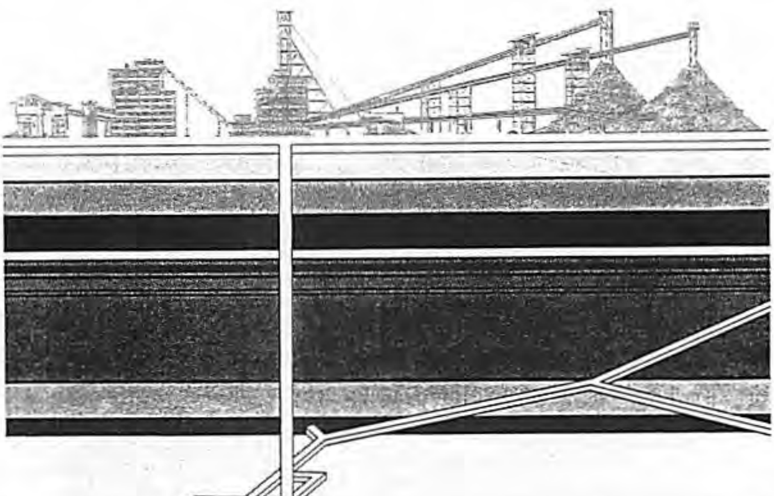


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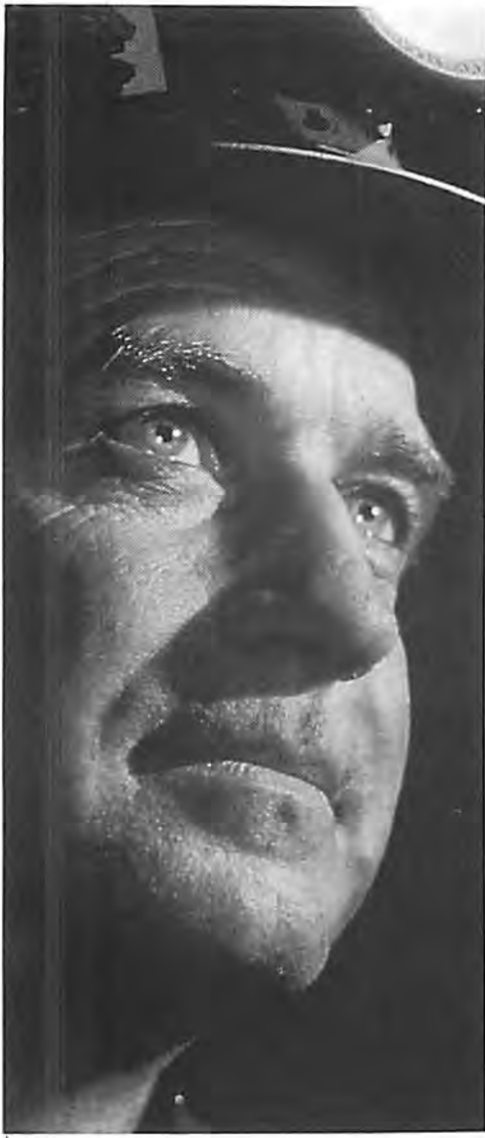

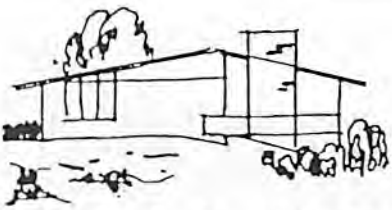

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Building Materials and Construction

Contractors and Professional Services (consultants, engineers, drilling, etc.)

Electrical Equipment (supplies, motors, cables, lamps and repairs)

Altorfer, Inc., p. 205
Ashby Electric Co., Inc., p. 144
Crown Battery Mfg. Co., p. 191
Du Quoin Iron & Supply Co., p. 185
Fairmont Supply Co., p. 176
Flanders Electric of Illinois, Inc., p. 159
Henry A. Petter Supply Co., p. 160
Hopcroft Electric, p. 168
IBT, Inc., p. 172
JH Service Company, Inc., p. 135
Kerco, Inc., p. 216
Kirby Risk Electrical Supply Co., p. 195
Mohler Techology, Inc., p. 174
Mt. Vernon Electric, Inc., p. 199
National Mine Service Co., p. 147
Ocenco, Inc., p. 136
Reaco Battery Service Corp., p. 197
Triune, Inc., p. 153
Woodruff Supply, Inc., p. 190

Mining and Industrial Supplies

Arneson Timber Co., p. 139
Associated Supply Co., p. 170
Century Lubricants Co., p. 214
Construction Machinery Corp., p. 145
Excel Mining Systems, Div. of ANI Metal Products, Inc., p. 198
Fabick Machinery Co., p. 148
Fairmont Supply Co., p. 176
Fansteel, Inc. - VR/Wesson Co., p. 167
Fosroc, Inc., p. 203
G. W. Van Keppel Co., The, p. 140
Gauley Sales Co., p. 158
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Martin Marietta Aggregates, p. 206
MICON Products, Int'l., Inc., p. 208
Mine & Process Service, Inc., p. 146
Mine Supply Co., The, p. 211
National Mine Service Co., p. 147

Mining and Industrial Supplies, cont'd.

Mining Companies

Petroleum Products and Chemicals

Power Transmission Equipment (services and parts)

Preparation Plants and Equipment (services and Parts)

Pumps (all kinds, pipe valves, fittings, hydraulics)

Reclamation, Erosion Control, Ground Stabilization

Rubber Products (tires, belting and hose)

Steel and Steel Fabricators (screens, rail, etc.)

Surface Mining Equipment

Transportation (railroads, trucking, barge)

Underground Mining Equipment (equipment, replacement parts and rebuilds)

Underground Mining Equipment, cont'd.

Underground Roof Support, Safety and Ventilation

Users of Coal (utilities, industry, etc.)

Other

ALPHABETICAL INDEX