SUBJECT: Operating Research Department - Year 1958

Mr. Hugh J. Leach
Manager, Michigan Mines

Dear Sir:

I herewith submit to you the 1958 Annual Report of the Operating Research Department. Although the department was disbanded in July, 1958, the final portion of this report, headed "Special Projects", includes the activities of the writer for the balance of the year.

Itemized below are the projects that were completed in 1958.

INCENTIVES
1. Mather Mine "A" Shaft - Revision of the inclined drift incentive.
5. Bunker Hill - Establish an incentive and proper working procedure for driving mining drifts that use two different weights and sizes of yieldable steel arches.

TIME STUDIES
2. Cliffs Shaft - Comparison of carburized steel drill rods with carbon steel drill rods.
3. Cliffs Shaft - Testing various manufacturers tungsten carbide bits.
5. Cliffs Shaft - Comparison of grinding wheels for sharpening tungsten carbide bits.
GENERAL PROJECTS

1. Chain Conveyors.
2. Auger Miner.
3. Ditch Cleaners
4. Prestressed Concrete Sets.
5. Rock Drill Oils.
6. Conversion of the CP 555 to Remote Controls.
7. Miscellaneous.

SPECIAL PROJECTS

5. Cascade - Study on reserves, analyses, ore structures, plant layouts, and mining plans.
6. Industrial Television.
7. Mather Mine Screening Study.
8. Pellet Plant - Car thawing equipment.
10. Mather Mine "B" Shaft - Inclined drift study.

INCENTIVES

Prior to July, 1958, the Operating Research Department was requested to conduct time studies and work methods studies to establish, revise, and review incentives at all of the larger underground properties.

At the Mather Mine "A" Shaft, this department was requested to establish a revised incentive in the inclined drift because a men and materials handling car had been installed in the drift. This incentive was set up on increments to adjust for scraping distances from the drift heading to the conveyor belt.

Three incentive studies were made at the Mather Mine "B" Shaft. The first study was to establish a rate per foot of raise for the Raise Cage Method of advancing raises. The regular rate for raising by conventional methods was
INCENTIVES -contd.

$11.50 per foot of raise. The new rate that was developed for the Raise Cage Method was $8.75 per foot. The overall saving by this new method is not completely reflected by this $2.75 difference in rates. The conventional method requires two raises as compared to one for the Raise Cage Method. This would result in an actual saving of $14.25 per foot of raise advanced.

A work sample study was conducted on drift repair work at the Mather Mine "B" Shaft. After posting the data accumulated in February it was found that there was so little correlation of the information that no practical incentive could be calculated. A great deal more information would have to be obtained before a workable incentive could be developed. A subsequent reduction in manpower to further the study made it necessary to abandon this project.

The third study was a review of the long hole drilling incentive. It was revealed that due to the installation of the chain conveyor in a mining drift more drilling time was made available for the miners and a reduction of $.05 per foot from $.35 to $.30 per foot could be justified. However, the Mather Mine personnel acquiesced to the Union's statement that there was no increase in the rate of drilling, but solely in time per cycle for drilling. This new rate was discontinued.

At the Bunker Hill Mine, a new method of support in mining drifts required a time study to establish an incentive for driving these drifts. This new drift required larger cross sectional excavations at the mill locations and careful installation of these mill sets. Because of varying ground conditions, it was necessary to establish two rates, one for regular drifting and the other for drifting with pipe spiling.

Due to the high swings that were occurring in the stope miners pay at the Cliffs Shaft Mine, Mr. Marjama asked our department to assist in a review of stope rates. It was found that back in 1948 or 1949 an additional incentive had been offered Cliffs Shaft miners by increasing their stopping rate, after 40 cars/shift, from a 82-18 curve to a 75-25 curve. Actually, this 75-25 calculation is a flatter curve or lower increment per car payment than the other mines are using. However, the increase in payment caused the Cliffs Shaft personnel concern. It was suggested that no revision in the incentive be made, but a closer control of tramming be exercised so that the contracts would not go above the 40 car per shift average.

This situation is peculiar to the Cliffs Shaft alone because of their system of accumulating a pile of ore to use as a means of mining the backs of stopes. This results in no production from a contract in some months and an excessive amount when the accumulated ore is being moved. As previously mentioned, closer control is being exercised in these cases.

TIME STUDIES

The Mather Mine "B" Shaft personnel requested a work methods study of the steel set shop to establish the best shop layout and shop practices that could be instituted in the space available. When the study was completed, a new layout of equipment was made, and the work procedure of the men involved was altered. These changes, with the addition of some equipment, provided a much more efficient operation. It resulted in the immediate reduction of one man and an ultimate reduction of two men from this five man operation.
TIME STUDIES — contd.

With the assistance of Mr. J. P. Meyers, Engineer at the Cliffs Shaft Mine, numerous equipment testing studies were conducted at the Cliffs Shaft Mine.

A test of carburized steel proved that it wasn't economical to use this steel because of the higher initial cost, as well as lower drilling footage, than the carbon steel presently in use.

Several comparison bit tests were made with favorable results. Continued testing is being done in mining contracts to determine whether the same favorable results will be obtained in actual mining operations. These tests will continue into 1959.

Other tests conducted at the Cliffs Shaft Mine were on drill machines and grinding wheels for carbide insert bits.

The experimental model X-793 Ingersoll-Rand integral leg was compared with the other production machines underground at the Cliffs Shaft Mine. The X-793 Model proved to be 18.5% to 64.5% better than other machines in its weight class in the penetration tests. The handling ability and general performance of this machine were satisfactory. Because the machine is so new, no maintenance costs were available.

In the grinding wheel tests, the Bay State "L" hardness wheels outperformed the comparable Carborundum wheels by 28%. Mr. Meyers estimated that by using Bay State wheels an approximate saving of $525.00 per year could be realized at the Cliffs Shaft Mine.

A study was undertaken at the Tilden Mine to determine the efficiency of the Ingersoll-Rand "Down the Hole Drill" when drilling in the West Pit. This machine was drilling with the 6½" Carset X bit. The overall performance of the drill was satisfactory, however, a trial of a larger machine with a 9" bit has been requested.

GENERAL PROJECTS

1. Chain Conveyors

The 1957 Annual Report for the Operating Research Department discussed in general the savings that could be realized by the use of chain conveyors rather than scraper hoists underground. In an additional effort to investigate the degree of savings in labor and wages, the Mather Mine "H" Shaft agreed to keep special records on scraper hoist maintenance costs for 1958. However, due to the curtailment of operations and the cut-back in office and supervisory personnel, these records were not obtained. From this information, a final report on the justification of the use of chain conveyors in suitable applications was to have been written.

When the chain conveyors were originally introduced underground, it was estimated that if it was possible to get 70,000 tons of ore over a conveyor before the chain was replaced it would be considered an economical operation. During 1958, several chain conveyors have handled over 120,000 tons before the chain was replaced, and one conveyor has handled 171,783 tons of ore and will continue in use when this area is back into production. We have estimated that the chain is providing us with over 50% more life on the average than had been originally estimated.
1. **Chain Conveyors - contd.**

   In January, 1958, a chain testing machine was devised and a record of chain strengths after a given period of use was started. When the W. B. Thompson Company and Walter Herold heard about our efforts, they volunteered the services of the Thompson Company personnel and Walter Herold's shops facilities to handle this testing program if they, in turn, could utilize the information. Presently, several chain conveyors at each property are delegated as the test units. A sample of chain and an over-all inspection, with photographs, is being made of these conveyors for every 10,000 tons of ore conveyed. In another year's time, a good set of performance standards can be formulated for the operation and life expectancy of all parts of the chain conveyors.

   During the latter part of 1957, this department started designing a new Z section pan for the chain conveyor. We estimated that a $100.00 or 35% saving could be realized per pan if the mine shops would build these pan sections. The drawings were completed in June, however, due to the reduction in labor force at the mines nothing has been done since July.

   Another equipment supplier heard of our Z section pans and in December supplied the Mather Mine "A" Shaft with a chain conveyor using this type of pans.

   From the time that the chain conveyors were introduced until the time that our department was disbanded, whenever a new application for a chain conveyor was to be made or whenever out of the ordinary trouble was encountered in the operation of a conveyor, members of this organization were used as designers, supervisors, and trouble shooters.

2. **Auger Miner**

   After drilling with the auger miner had been completed at the Bunker Hill Mine late in 1957, it was decided to transfer this equipment to the Mather Mine "A" Shaft to mine the interbedded ore. The 7200 X-Cut on 7th Level was picked for the initial trial because due to the flattening of the dip of the orebody approximately 160' of interbedded ore was exposed in this drift.

   The plans called for drilling an upper and lower hole on each side of the drift. In order to drill the upper hole, it was necessary to extend the hydraulic jack legs four feet above the rails. This set-up wasn't very safe so several devices had to be designed to insure the stability of the rig while drilling. Several other revisions were made to improve the operation of the auger.

   Since the drilling was to be done from the level elevation, a chain conveyor installation had to be designed so that the ore that was mined with the auger could be elevated into tram cars. This design included double vertical and horizontal curves which were a source of trouble at the outset until the proper tensioning of the side chains was accomplished.

   During the time that the conveyor was installed and the auger equipment was being assembled, it was necessary for men from our department to supervise the job. In May, when augering was begun, a member of this department was assigned to this project on a steady basis because operators had to be trained, and due to the hard ground encountered, several new designs of the auger head had to be made to cope with the ground conditions. This man stayed on the augering job until the department was disbanded in July.
3. Ditch Cleaners

There are two types of ditch cleaners in use in the underground mines, the Gafner Hydraloader and the Sherman backhoe.

The Gafner Hydraloader is a pulpwood loader that was redesigned by our department for ditch cleaning. The unit is mounted on a regular mine truck and is cageable. All motions of the loader are hydraulically controlled and the hydraulic pump is operated by a 5 h.p. D.C. electric motor that can be powered from the trolley line or a battery locomotive. This loader can load directly from the ditch into cars.

The Sherman backhoe type ditch cleaner is also completely hydraulically controlled. A 10 h.p. D.C. motor is used to run the hydraulic pump. This unit does an excellent job of digging very hard compacted material. It does a fairly good job of cleaning mud, however, it cannot load directly from the ditch into tram cars because of head room clearance. This unit is not cageable.

A comparison of performance of these two loaders was made at the Mather Mine "A" Shaft and it was decided that both of these ditch cleaners have a definite application in our underground properties.

4. Prestressed Concrete Sets

The use of prestressed concrete sets was tried at the Mather Mine "B" Shaft. These sets were manufactured by the Northern State Dunbrik Company of Negaunee. The sets were very heavy and cumbersome to handle, both in transporting and in mining contracts. In their use for support in a transfer drift, in an area that wasn't considered to be too heavy ground, the sets did not prove successful. It was observed that the caps would fail at both ends at the joggles. The legs would sheat at the top ends at an angle of 45° across the leg. It was assumed that because of the rake of the leg the concrete was not able to provide its strongest element which is compression. The caps, in turn, were built heavy in the middle with a much smaller section at the joggles where an equivalent amount of support is required and thus failed at those points. No further work has been done with the concrete sets.

5. Rock Drill Oils

At the request of Mr. Iver Johnson, Purchasing Agent, an investigation of rock drill oils was started. Mr. Johnson pointed out that there is a big variation in the prices of rock drill oils as supplied by the various oil companies. To be specific; the Standard Oil Company was supplying our company with their Non-Pareil Rock Drill Oil at $0.82 per gallon (federal tax included) while the Texas Company was willing to supply us a comparable oil for $0.52 per gallon (federal tax included).

A comparison of specifications of the different companies' products didn't prove anything conclusively. Letters were then written to the American Society for Testing Materials, The M. A. Hanna Company, The Anaconda Company, and the Climax Molybdenum Company to get the benefit of any information or practical experience that they might have that could be made available to us.

The American Society for Testing Materials didn't answer at all. Climax Molybdenum Company did not have any information because they had never delved into the investigation of lubricants. The M. A. Hanna Company of Iron River were using both the Standard Oil and Texaco products, but preferred the Texaco rock drill oil strictly from a cost standpoint because they had never made any performance comparisons. The Anaconda Company had made very extensive tests and Lester Bishop of

The Anaconda Research Department provided us with their results. The Texaco EP rock drill oils were ranked highest by them on a performance basis.

This information was submitted to Mr. Johnson and the operating superintendents and presently the mines are using the Texaco product.

Considering the fact that our company used over 13,000 gallons of rock drill oil in 1958, a $0.30 per gallon saving amounts to approximately $4,000.00 per year.

6. Conversion of the CP 555 to Remote Controls

The Mather Mine "B" Shaft operators requested our department to investigate the merits of a remote control conversion unit that had been developed by their drill repairman, Mr. Peter Belpedio, for the CP 555 long hole rotary drill machine. Our study approached the subject from a production, safety, and cost standpoint.

Production was not improved appreciably, however, from a safety angle the cost of conversion could readily be justified. The cost of the conversion amounted to $99.35.

The remote controls will eliminate the numerous slight and compensable hand injuries that have occurred during the operation of the rotary drill. With remote controls, it also permits the use of the rotary drill near mill openings without endangering the miner as it had in the past. It also places the miner further away from the rotating rods, which in June, 1954 almost cost the life of a miner when his clothes became entangled with the rotating rods.

7. Miscellaneous

Early in January, 1958, the Pellet Plant was having considerable trouble with their hot materials product belt, and they were afraid that they might be forced to shut down. Mr. Rembold asked our department if we thought a chain conveyor could be substituted for this belt conveyor until a replacement belt could be delivered. We knew that the chain conveyor could handle the pellets up the incline, but we couldn’t predict whether the pans would warp due to the heat. Nevertheless, arrangements were made with the underground mines for a chain conveyor and the Operating Research Department was prepared to install the conveyor whenever it was needed. If the chain conveyor would have had to be used, it would have required removing all the belt idlers and the chain would have been installed on the conveyor belt deck. Fortunately for the Pellet Plant, it was not necessary to use the chain conveyor, thus eliminating a great deal of extra work.

Members of this department were called upon to observe mining or other operations to determine whether improvements could be made. These projects would normally result in a method improvements time study that would revise the working procedure to improve the output of the persons involved.

In February, the Bunker Hill-Masa Mine requested that we conduct a mine water survey to try to reduce the moisture in the product. After two weeks of survey with the Mine Superintendent, a 2% reduction in moisture in the mine product was realized.
SPECIAL PROJECTS

Due to the economic conditions affecting the iron ore industry, Mr. W. A. Sterling, President and Chairman, requested Mr. Grover J. Holt, Assistant to the President, and the writer to make several special studies of the operations on the Marquette Range, that would result in curtailment of production and layoffs of employees. These studies were to be made entirely independent of the operators, and were to establish the most suitable operating schedules and working force to insure The Cleveland-Cliffs Iron Company a profitable year despite the economic dilemma confronting independent iron ore producers.

1. Bunker Hill-Maas

At Mr. Sterling's request, a study was made of the Bunker Hill-Maas Mines. The report was to contain recommendations for the best method of obtaining a small operation and still keep the mines alive; yearly maintenance cost figures if these mines were shut down; and the cost if the mines were shut down and flooded without maintenance.

On the basis of the findings of this report and the independent study prepared by the operators, the Bunker Hill-Maas Mines continued to operate in 1958.

2. Marquette Range Personnel

In June, Mr. Sterling requested that Mr. Holt and the writer make a survey of all the salaried and hourly rate employees on the Marquette Range and determine the maximum economic reduction that could be made in the overall working force, on the curtailed production schedule, without hurting the Company's operations. This study was also conducted independently of the operators. When the two studies were completed and compared, a final recommendation was made to Mr. Sterling and a layoff was made relative to the findings of the two studies.

Excluded from these studies were the clerical personnel which was handled by Mr. W. E. Doehn.

3. Cambria-Jackson

In February, Mr. J. S. Westwater requested the writer to investigate the operations of the Cambria-Jackson Mine to prepare a Budget Cost of Production for 1958, and to recommend to Mr. R. L. Tobie, Superintendent, any possible means of reducing costs. It was recommended that the watchmen at the Mather Mine "B" Shaft could include the Cambria plant as part of their duties, thus eliminating three men from the payroll. A reduction in the maintenance crew was discussed with Mr. Tobie which also resulted in a reduction in the labor force.

4. Mather Mine

In August, Mr. Westwater requested that the writer make a study of the most economical operating schedule for the Mather Mine on a $,500,000 total production basis. Production schedules, working schedules, estimates of the labor force, and the resulting production costs were prepared for both shafts.

A two shifts per day, four days per week, no "honey-do" week schedule proved to be the most economical. This new operating schedule resulted in another reduction in the labor force.

5. Cascade

On December 17, 1957, Mr. Boyum submitted a report entitled "Data for Special Reserve Study" that indicated the total tonnage of estimated Cascade direct shipping ore. This information had been accumulated as the drill holes had encountered the ore with no reevaluation of the entire drilling data. It was requested of the Geological Department to have an independent estimate made by one of the other departmental geologists. It was suggested that he check all the core, all of the analyses, and calculate a new estimate. The estimates checked within 3% of each other, which was assurance that the original estimate was relatively correct.

At the same time it was suggested that a complete chemical analysis was to be made of the Cascade core for the possible presence of the following elements: arsenic, nickel, sodium, zinc, potassium, copper and chromium. Our Chemical Laboratory found the samples to be free of these elements. As a further check, samples were sent to Michigan Tech and a spectrographic analysis also proved the samples were free of these other elements.

Another study was made to compare the Diamond Drill core analyses with actual mining analyses. Experience at the Mather Mine "B" Shaft indicated that actual mining analyses were always somewhat lower than the drill core analyses. A check was made at the Mather Mine "B" Shaft and an average of both the 7th and 8th Levels showed that mining samples were 2.25% to 2.50% lower in iron than the drill core samples.

Mr. Westwater then requested the writer to try to establish a moisture content of the Cascade ore. It was decided to take core samples of the Mather Mine, Bunker Hill and Maas ores and compare them with the Cascade core to see if any basis for establishment of a moisture content could be made. Upon visual inspection, it was decided that the Cascade ore compared the closest with the Mather Mine ores.

In trying to justify the observations made it was decided to ask Mr. Tsu Ming Han, Mineralogist, to run a microscopic analysis of the ores. Mr. Han was informed of what we were trying to accomplish. He stated that he could not only make a grain size comparison, but he could establish the porosity, the rate of absorption and evaporation of water, and the percentage of the different minerals present in the various ores. Mr. Han believed that he could, through his methods of study, give us a much more accurate picture of what to expect in moisture content and structure at the Cascade.

On the basis of the tests conducted by Mr. Han and Mr. Don Lukkari, Geologist, it was concluded that the Cascade ore is essentially made up of more than 60% non-porous martite and less than 40% soft earthy hematite. Physically, the Cascade ore is a fairly hard porous and granular ore having a maximum moisture content of not more than 9%.

In light of all the information from actual mining experience, recheck on drill analyses, and Mr. Han's and Mr. Lukkari's report, it is safe to assume that for the 40,362,000 tons of standard ore at the Cascade, the estimated average analysis will be between 54.50 and 55.00% natural iron.
5. Cascade - contd.

The report by Messrs. Han and Lukkari uncovered an entirely new approach to the evaluation of iron ores, and may be invaluable to the Company in future studies.

Early in 1958, we were informed by the Geological Department that the Richmond Pit contained a considerable amount of M.O.C. ore that could enter the mining picture. This possibility made it necessary to investigate an alternate site for the surface plant of the underground mine. Seismic surveys were run to determine the best possible location for the alternate site, however, due to the reduction in personnel, the job was never completed.

Several letters were written relative to the mining methods and the most ideal location along the footwall to begin mining. Due to the estimated flat dip (20°) of the upper part of the orebody, the idea of initiating the mining in the lower portion of the orebody has been considered. There are several reasons in favor of this approach, mainly: the mass of the orebody is located in the middle of the lower two-thirds of the present known orebody, the center of the mass of the orebody is the shortest distance to the original shaft location and by not mining the top one-third of the orebody a cave through to surface would not occur as rapidly, thus minimizing surface water problems. Because of the flat dip of the footwall, mining in this method should not hinder any future mining of the upper portion of the orebody.

Many problems remain untouched, but nothing can be definitely resolved until a permanent shaft location is established and the opportunity for further study is granted.

Because of the need from a safety, a production, and a ventilation standpoint, two shafts 75 ft. apart have been planned for the Cascade. It occurred to us that presently Michigan does not have a mining code, but with the Union's persistent efforts to get a mining code, the possibility of a minimum distance requirement between shafts may materialize. An investigation of minimum distance requirements between shafts of the various states, and Canada, that do have codes were made. It was found that the distances varied from 30 ft. to 200 ft. with several states not mentioning a minimum spacing. The study showed that the average or most common spacing was 50 ft. Mr. Clancey, Attorney, was consulted and he stated that if we did have our 75 ft. distance between shafts prior to any mining code that might be passed in Michigan, the State would not require an operating mine without the minimum distance between two outlets to sink a third shaft in order to come within the terms of the legislation. It was also Mr. Clancey’s opinion that with most of the states having a 50 ft. spacing between outlets, Michigan would very likely hold to the same spacing.

The Mechanical Department has made a drawing of our proposed two shaft, headframe, and engine house layout.

A model of the Cascade orebody was constructed by Mr. Edward G. Rosar of the Operating Research Department with the help of Mather Mine "E" Shaft carpenter shop personnel. This model is presently situated in the Engineering Building.

No further work was done on the Cascade East End Project.
6. **Industrial Television**

At the request of Mr. Fayette Brown, Jr., Assistant Vice President, a report was prepared on the "Use of Industrial Television on the Marquette Range". The report contained information on past, present, and future applications of television in the plants and underground mines. It showed the savings in labor and wages that are being realized by present installations and where future applications can justify similar economies.

7. **Mather Mine Screening Study**

In September, plans were made to run a series of screening tests of the Mather Mine ores at the Ore Improvement Plant to establish the maximum moisture content of the ores that can be screened without drying. This test was necessitated by the present demand for the 3/8" sinter feed product. The tests were to determine whether screening at the mines would be feasible, or if drying of the mine product would be required to efficiently produce sinter feed material.

The results of the test proved that it was difficult to establish a maximum moisture content of Mather Mine ores that can be screened without drying, because of variations in structure and mineral content of the ore. It was agreed that the best and surest means of determining a screenable product is by visual inspection.

It was concluded that in view of the fact that the Bethlehem Steel Company is requesting a sinter feed product with a lower moisture content than the 7.68% that was delivered in 1958, drying before screening will be necessary to produce the desired product.

In conjunction with the screen tests, two new pieces of equipment were also investigated. A Bixby-Zimmer loop deck screen cloth was installed on one of the screens. Screening efficiency, from the point of view of a sharp break in oversized and undersized product, was not improved, however, this screen deck did not blind over because of build up at all. In this respect, the screen did operate more efficiently than the Ludlow-Sayler cloth that is normally used at the Ore Improvement Plant.

Additional screening studies will be conducted in 1959.

The other equipment investigated at this time was the installation of Chromalox infra-red heaters. The claim was that these heaters would reduce the moisture content of the ore as it passed over the screen, which would result in improved screening efficiency and also improve the product by increasing the natural iron through this moisture reduction. The tests proved that there was no detectable reduction in moisture, however, the Chromalox heaters did keep the top deck of the screen completely void of build up, while the screen that didn't have the heaters required constant attention to eliminate this build up of material. It was agreed that the heaters did an excellent job in this respect.

8. **Pellet Plant**

The supplier of the Chromalox infra-red heaters requested permission to quote on an ore car thawing unit for the Pellet Plant which would purportedly do a better job of thawing cars than the proposed new thaw shed. The initial cost of the unit was comparable to the thaw shed, however, the operating cost was prohibitive. The Chromalox infra-red heaters would consume $1,400 worth of electricity in a normal operating year compared to $2,000 worth of fuel oil for the conventional thaw shed.
9. Raise Hoist Method of Advancing Raizes

In December, Mr. H. J. Leach, Manager, circulated some information on a new type of a "Raise Hoist" or "Raise Platform" which is being developed in Sweden for advancing raises. Mr. I. G. Johnson was requested to contact the Alemac Works of Sweden to get additional information. The Raise Hoist is a self propelled platform that rides on a gear-toothed rack that is rock bolted in sections to the hanging of the raise. The method of raising is similar to the working cycle employed by the Raise Cage.

This equipment is being investigated because either the Raise-Hoist or the Raise Cage will be used to drive the pilot raise for the Mather Mine "A" Shaft men and materials handling winze inside on 10th Level.

This project will be completed in 1959.

10. Mather Mine "B" Shaft Inclined Drift

A study is being initiated to determine the best mucking and materials handling equipment for advancing the 10th to 12th Level Mather Mine "B" Shaft inclined drift. Work methods studies are being calculated to compare loading machines with scraper hoist operations. Studies are also being made of single skip, two skips with a California switch, and shuttle belt materials handling setups.

This is a 1959 project.

CONCLUSION

Prior to the termination of the Operating Research Department's activities in July, 1958, various other projects were in the process of study and resolution. The most important of these were: a complete report on chain conveyors - their application and the savings that can be derived; and a compilation of information on the cost of operating loaders underground. Another important project that was left incomplete, as far as the Operating Research Department was concerned, was the Auger Miner.

The members of the department felt that an important function was being performed by this organization. Our belief, and the opinions volunteered by the operators, is that such a department has a definite place in a progressive company such as The Cleveland-Cliffs Iron Company, particularly, when wages continue to climb.

John M. Halvalla
Operating Research Department

JMH/ca
1/20/59