A PHILOSOPHICAL APPROACH TO 21ST CENTURY COAL MINE PLANNING

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ABSTRACT

In designing for a highly productive new mine during the present declining coal market, a very detailed planning is necessary. Attitudes of both management and coal operators may have to be changed, with more initial participation by the unions, governmental agencies, and the coal owners.

A considerable number of Australian mines are remote from labour source and this trend is likely to increase particularly in the state of Queensland. Consequently such mines must be developed on the basis of the future technological and social changes in order to minimise both the capital and operating costs.

INTRODUCTION

The essential elements of a high productive system include the degree of mechanisation and roof support systems. Other critical factors are: the geology, ground control and environmental issues (both surface and underground). Seismic methods in a very close pattern across the field is one of the more recently recognised techniques for proving the coal geology structure.

A leasehold boundary should not be confined to a pre-dimensioned area, but should represent the most economic area which is limited by structural constraint or some form of a physical barrier. The mine should have the least effect on environment and commensurate with the highest reserves recovery.

This paper attempts to address various issues confronting the year 2000 with planned mines capable of meeting world wide competition especially from third world countries urgently seeking capital and prepared to undercut traditional Australian markets.

MINE LOCATION

The location of any pit top where coal is produced or where men are required to enter the mine is governed by mine infrastructure. Availability of port facilities and a suitable labour source are the important factors which control a pit top's location. However, it is more economical to construct a central facility to service a mine complex. The cost of a preparation plant, workshops and stores precludes duplication. Additionally, the extension of transport services from the mine to other locations would be an added cost. The application of satellite shafts or drifts for men and services may be much more desirable in remote areas. The physical, geological and structural conditions of the leasehold, if properly established, will provide the most effective method of planning a mine complex. A case may be made for the development of a coalfield rather than a leasehold. The trend in Europe is to have a mine complex operated from a central top with separate ventilation in most cases. The ROM reports to a central.
common preparation plant. Labour force may be drawn from the various areas depending on the location of mine entry.

In remote areas with no social infrastructure, e.g., Central Queensland, consideration may be given to the fly in and fly out philosophy similar to Agnew new mine in Western Australia and oil platform operations, where 24 hours per day and 7 days a week is a norm.

Having defined various points of entry to the mine complex, the proposal must be acceptable to the management and unions. The financial aspect involved will require to be formalised at the conclusion of the feasibility study.

**EQUIPMENT UTILISATION**

Basically equipment utilisation is a factor which represents the maximum production time an equipment can operate in a year. Longwall mining is a typical example of the need for high equipment utilisation. The success of longwall mining in this country will have a significant effect on the Australian coal production. Furthermore, roof bolting technology has contributed to higher production from solids development. Whilst improvement in the design of continuous miners and longwall equipment has contributed to the increased productivity, it must be recognised that it is in the application of well established roof control practice that high productivity can be forthcoming.

Continuous miners are still utilised for the production of pillar coal using Wongawilli system. In spite of the improvements made to date, they still fall short of achieving high tonnages compared to longwall system. One aspect which is recognised is the influence of effective maintenance on the overall equipment utilisation. It should be emphasised that the maintenance quality must be commensurate with increased demand on the equipment. This is one of the challenges facing management. Management in engineering requires a much more professional approach to the application of the maintenance program in a mine. It is believed that once such a scheme is initiated, a more casual approach to the program will be evident as the management chart progresses through to the coal face. It is insufficient to send a fitter or an electrician down to perform a repair or maintenance service without proper coordination with other units of operation.

Diagnostic assessment of equipment is an area which has not yet been efficiently implemented. If equipment is to be operated 360 days per year, then engineering and management must recognise that future equipment design should include some form of maintenance program. Planned maintenance program is very useful but there is a danger of producing a program which can be self defeating. During the early NCB days the worker had to fill the maintenance report form after a work has been carried out but not necessarily completed.

Any equipment failure should be thoroughly investigated to the extent that the quality of the failed item should be examined and adequately recorded. Similarly, an equipment failure should include a review of operation at the time of failure. Operators traditionally are noted for having scant respect for equipment with the assumption that the equipment should be robust enough to accept any abuse without failure. Operator training should include the limits and design criteria of the equipment rather than a mere driving or operating the plant.

**MANNING**

The future of coal mining industry requires that employees may have to work hours which are normally considered external to the traditional working practices. In many industries a person may be employed for the whole of his working life on a socially unacceptable shift. Many miners have been known to prefer this arrangement but no real research has been done to evaluate the social effects on family life.

The future manning for a mine will not be a simple case of finding labour. There will be a problem in the selection of suitable labour with
capacity to accept a more formalised training. In order to insure optimum use of capital equipment, provision of a better life style for employees in coal mining industry must be part of design philosophy, planning and training. It is obvious that an employee's life-style cannot and should not be planned by an employer. Compromise however will be necessary to obviate the social problem.

It is not suggested that the problems of shift work will disappear. Financial incentive alone may not be the sole factor in solving the social problems. Major competitors in the third world countries can utilise financial incentive equally. Hanpower, therefore must be trained for optimum performance if this country is to remain in the forefront of coal export market.

The current working practice entails that the operator has seven hour shift which includes two travelling times and crib time. In reality this means that the operator may only have to work 5.5 hours in a shift to produce coal. A case can be made for the review of existing work practice, in order to optimise the use of resources in the coal mining industry.

As a basis for argument, the following scenarios are proposed with regard to work practices.

(1) The current situation whereby an employee works 7 hours per day, 35 hours per week and 230 days per year of the miner.

(2) An employee working 7 hours per day, 7 days per week and 360 days per year and still retaining 35 hours per week norm. The number of extra hours available are made up by additional employees.

(3) Working 12 hours /day, 7days/week, 360 days / year and maintaining 35 hours/ week principle.

The third scenario is already being implemented in some industries, e.g. oil platforms. This permits the introduction of fly in, fly out concept to remote areas, obviating the social problems associated with shorter shift works.

Recent studies conducted by Computer Science of Australia and the Occupational Health Division of the NSW Department of Industrial Relations (Sydney Morning Herald, February 16, 1986), showed that the results of 12 hour roster shifts created happier and healthier employees. About 40% of the employees reported less gastrointestinal problems and had a much more acceptable sleep pattern. In addition, productivity was improved and accidents were reduced.

Having considered the three scenarios, it is believed that the scenario 3 can result in the following advantages:

(1) increase in coal production,

(2) flexible holiday time period without the need to carry excessive manning to cover absences,

(3) call up system where a man on holiday can be used as a substitute for an urgent needs of the mine such as longwall face transfers.

SHIFT LOADING

Whilst shift loadings are a means of compensating an employee for unsociable hours, this is the most inefficient and least cost effective method of compensation for the loss of social benefit. Indeed the very need to optimise capital equipment can be self defeating if financial considerations are the only means available. The answer is to change the award structure and also traditional working hour arrangement noting that there is some advantages already recorded above. The workforce will require to be upgraded to optimise equipment utilisation. It is not suggested that an increase in the number of working hours be proposed for one year work. The proposed is to retain this figure but to change the hours worked in a single shift without any overtime loading or a review of the method of compensation e.g. reduction of shift time if the dog watch is a maintenance shift.

12 - hour day no bellyache for workers, Sydney Morning Herald, February 16, 1986. p2
This amounts to additional wages bill against additional increase in production. The benefits of such scheme is to provide and optimise the social, health and economic benefits to the employer and employee. It would be evident that this system could reduce unemployment in mining which would otherwise decline.

TRANSPORTATION

Transportation in a mine comprises three separate categories. These are:
(1) coal transport
(2) men transport
(3) materials supply transport

If these three categories are closely examined, it is evident that the increased utilisation factor for coal production will require a much higher standards from transport.

BELT CONVEYORS

In the immediate succeeding years, it is likely that belt conveyors will still constitute the main method of coal transport from the face to the preparation plant. Future consideration must be given to the introduction of high capacity hydraulic or pneumatic conveying. The trend today is to install larger belt conveyors both in panel and trunk conveying with little real extension of speed of conveyors as an alternative to installing wider belts. Examining the cost split up for a conveyor installation, the cost of the belt is some 30% of the total cost. At present, panel belt life is shorter than past experience and trunk or gathering conveyor belt life appears to be following a similar trend. A factor influencing this is the higher rate of loading demanded on the conveyor. This can lead to a false idea of cost per tonne for replacement.

Conveyors of 200/300 kW are very common in the mine but these do not receive the same detailed attention during installation as a conveyor in a slope application where steel chord or synthetic fibers may be used. Operators expect 10-15 years life for a conveyor and one must ask why is there a difference in the anticipated life of the belt since the output of the mine is handled by one conveyor and it could be argued that more wear and tear may occur.

Increasingly coal sizing is being conducted at or close to coal face and any conveyor installation duty should be examined on load profile, cycle time and physical conditions. Much research work is required to produce a belt installation suitable for the duty rather than accepting that a conveyor is of a temporary nature with short life. The use of solid state starting with automatic belt tensioning should be designed such that the belt receives the maximum protection at start up rather than simply running the motor and drive up to speed. Too often the protective device is designed around the electricity for power control reasons.

Transfer points obviously can be a problem if not adequately designed and this particular aspect has not been solved by any means. Perhaps one should examine motorised transfer points.

Going back some forty years, conveyor designers in the United Kingdom applied a small tandem belts, driven from the return belt pulley at the boot end. Such a system absorbed the impact of transferred coal and also accelerated and delivered coal on to the boot end of the main belt. Whilst this system had drawbacks, for example belt tension problems, the principle was sound and handled the ROM output in several of the early 1950 installations in NCB mines where drifts were employed. The use of small transfer bins complete with such devices is attractive where transfer conditions demand. Finally, sizing of product may require in the future the production of a more acceptable product for conveying. The objective being is to minimise the need for crushing at the preparation plant. Further work may form part of the development for pipeline transportation.
MAN TRANSPORT

The philosophy behind man transportation should be the minimisation of non productive time from the pit top to the face, bearing in mind that a hot seat change over is desirable if possible. In which case it may be thought that travelling time considerations do not affect production continuity. Attempt must still be made to minimise travelling time. This contributes to the comfort of the worker by reduced exposure to noise, cramped conditions in many cases and generally uncomfortable seating when wearing equipment.

Detailed design of transport systems should be tailored with the physical conditions, e.g., undulating and steep workings can preclude off track operation. Similarly on track operation can also be limited for the same reason, requiring more specialised track areas in the mine. Monorail has not been adopted in Australia and can not be foreseen in this stage. Generally Australian mines floor conditions favour both rail and off track systems.

Belt transportation of men, although worthy of application and extension will require a separate system as coal should occupy the belt for 24 hours in a day and also has a disadvantage of requiring special arrangements at directional changes.

MATERIAL TRANSPORT

Research at the design stage of a mine should include the transport of materials into the mine and the transport of equipment for maintenance out of the mine. Batching and bulk supply needs should be examined and such a system should receive critical review as the mine progresses in order to control cost and minimise wastage.

Two problems have to be examined. Location of storage of consumables and loading and unloading of such materials requires much more detailed research than before. Obviously bulk supply of liquids can be simply controlled and are easily transported. Where men have to physically handle material, for example roof bolts, there has been no major breakthrough in the logistics. It can not be denied that there is a significant wastage of supplies at the point of consumption and the following very simple example will be readily appreciated by stores conscious staff. During a recent strike of a local mine, the store was manned by management staff and the amount of rags used in every shift proved to be 500% greater than the actual rags required. At the beginning of the week each shift consumed 3.5 bales of rags but by limiting supply of rags to small paper bags this was reduced to one bale per shift, amounting to 2/3 reduction in rag consumption. Of interest is the fact that the people coming forward for rags reduced to only leading hands and shift fitters as the miners accepted that rags were now under controlled supply. Needless to say less rags were noted lying on the rib and in areas where they could constitute a danger.

Finally the philosophy of underground men and material transport must be based on the particular needs, i.e., horses for courses. The transport system needs logistics research in the future to examine the case for building a transport system solely for men. Similarity material transport system must be designed to convey material alone.

EQUIPMENT SALVAGE

A visit to old panels often results in the discovery of discarded stringer structure, belting, cable and occasional return end or pulley. It can be more expensive to attempt to recover this gear at a later date but this situation needs attention if only for a suitable vehicle being designed around recovery needs.

ENVIRONMENTAL PLANNING AND EMERGENCY

Environmental planning to include mine ventilation system should be designed around a package based on the physical conditions. The scheme must include total monitoring, reporting and recording data designed to indicate change. Also it should be capable of being interfaced with mines rescue equipment. An ideal problem for a computerised system.

The AusIMM Illawarra Branch, 21st Century Higher Production Coal Mining Systems—Their Implications, Wollongong, NSW, April 1988

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USE OF COMPUTERS AS A MANAGEMENT TOOL

The future of coal mining industry will still rely on experienced personnel to plan a mine and safely mine coal. Computers will continue to play major role at various phases of a coal mine. With limited availability of "good" mining engineer, the application of expert system in mining computing a means to collect database of mining experts gives an alternative solution. An expert system in this context is defined as computer programs which incorporate judgement, experience, rules of thumb, intuition and other expertise to provide knowledgeable advice about a variety of coal mining problems. The potential application of expert systems in coal mining include mine monitoring system, mine planning, equipment diagnosis, mine safety and management decisions.

CONCLUSIONS

Increased productivity will continue to rise through the improvement in mechanisation and with possible annually round the clock working, the total output will rise. It must be appreciated that competitors in coal export market will match this performance in due course. The cost of labour difference can be detrimental to the Australian coal export market. Australia must be more efficient in management, placing even greater emphasis on material cost and control. This can only be achieved by education from the coal face to the board room. Operators must be regarded as technicians in production instead of being called miners. To this end greater emphasis on training of entrant to the industry must be applied. Age of technology will no longer accept physical output as a measure of productivity. With the introduction of seven days roster the coal mining companies should take the opportunity to introduce a social scheme to provide skilled training on safety, health, economics and ergonomics for healthier and fitter technician miners.