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Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

EXPLOITATION IN SMALL MINES - AN OUTSIDE VIEW PRESENTATION

Jay Pathak and John Udd

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L'exploitation des petites mines souterraines; vues de l'extérieur

(Exploitation in Small Mines - An Outside View)

After the second world war, the sudden surge in the construction and manufacturing industries placed an unprecedented demand on mineral supplies. The mining industries in developed countries, especially those which were not heavily war-damaged, were in a position to respond quickly to the increased demands for minerals. Unfortunately this period nurtured within the mining industry the misconception of sustained future growth in mineral demand; as well, no allowance was made by the industry in production planning for the entry of the underdeveloped countries into the then lucrative minerals markets. The result was that production capacity for most minerals exceeded world market needs. By the early 1980's mines and mining industries in developed countries, because of their higher living standards and worker's wages and competition from underdeveloped countries, suddenly found themselves struggling to survive. The Canadian mining industry, traditionally a conservative industry, responded to the challenge by taking drastic steps in terms of cost control and planning for the introduction of innovative technology. The drastic cost controls had the immediate effect of prolonging the lives some of mines but the marginal gains obtained by these measures were not good enough for the long term survival of the industry. It was quickly realized that the industry had to develop and accept new innovative mining systems if the mining industry was to continue to compete successfully in world markets. While the mere phrase 'innovative technology' or 'hi-tech' used to scare miners, to-day there is general agreement that the successful introduction of high technology to the Canadian mining industry is essential to its survival.

At this point, I would like to quote Hickson et al (1) of Australia, which I believe describes the worldwide thinking of miners and the mining industry in western industrialized countries today:

> *"Mining is a practical art that generally responds to, <u>if not initiates,</u> technological development in its quest to win metals profitably. However, an obsession with <u>'things that work'</u>, driven by the need to <u>minimize the unknown</u> in an already high risk business, tends to incremental or evolutionary step."*

It is also important to remember that it is not only competition from third world suppliers that is reducing the potential market for Canada's minerals. Competition is also coming from advances made in the invention, development and application of new materials, whose raw (source) materials may not be traditional mining industry products. The reduced consumption of metals in the automotive industry is in part attributable to the use of replacement materials as well as to the down sizing of the average passenger car. Over a 5 year period (1977 to 1982), the steel content of an average American car was reduced by 41 %, zinc by 71 % and copper and brass products by 10 % (D.S.Robertson, see fig. 1). It is estimated that the overall weight of an American car will be reduced by 41 % over the period 1977 to 1992, almost all of it by reducing the metal content (fig. 2). The copper and steel industries are presently suffering the effects of a lack of aggressiveness 10 years ago with respect to developing new products for the automotive industry. Metals are now being rapidly replaced by structural plastics, composite materials and ceramics, whose market is expected to be of the order of $ 20 - 50 billion in the near future. Even some of the leaf springs in Corvette sports cars are now being made of graphite fibre composite material. Also, in the communications industry fibre optic cables are rapidly replacing copper cables in some applications. This change in metal consumption directly effects the health of the mining industry. The planned retrieval of under sea copper cables by a consortium led by AT & T will be equivalent to the refined copper production of a number of mines.

The economic problems that the Canadian mining industry faced in the early 1980s can now be viewed as a blessing in disguise. It alerted the industry to the survival problems it was to face and provided the time to organize national resources for its survival. As a result, Governments, the mining industry through national and provincial organizations, universities, mining equipment manufacturers and hi-tech companies initiated planning excercises to meet the innovative technology required to sustain a healthy mining industry into the 21st century. The Canada Centre for Minerals and Energy Technology, (CANMET), the research wing of Energy, Mines and Resources, Canada, is a major participant in these exercises.

In the taxation area, the Government introduced 'flow-through shares' to financially assist exploration for new deposits which will lead to the development of new mines. As an example of the benefits of flow-through shares to the industry, Canamax has financed 60 million of its 85 million dollars expenses since 1983 with flow-through shares.

Since March 1986, CANMET has organized 2 workshops for the purpose of developing a mining industry consensus position on mining research priorities. These workshops resulted in the formation of the National Advisory Committee on Mining Automation, (NACMA). NACMA has since organized two Symposia, one in 1986 and the other in October 1987, which were very successful. The result of these activities has been much greater awareness in the mining industry of the importance of technological innovation in developing a survival strategy.

Under a M.O.U. between CANMET and the USBM, CANMET's American counterpart, information is exchanged on rockburst research, wire ropes testing and hoisting, and metal/nonmetal mine design. The three technical committees which have been established, meet at least twice a year to discuss current and future research. Recommendations are made to the respective advisory committees for further action.

The Mining Association of Canada - (MAC), has established 'The Mining Industry Technological Council of Canada - (MITEC)' to identify and set priorities for the industry's needs with respect to technological innovation. The Ontario Mining Association created the Mining Research Directorate - (MRD) in 1987 and the Quebec Mining Associations Committee on Mining Research define and coordinate their industries research requirements. The Canadian Institute of Advanced Minerals and Metals Technology (CIAMMT) has been formed to establish a national technology innovative strategy. It has been the driving force behind the establishment of Centres of Excellence on Geomechanics Research, Resource Studies, and Mine Automation and Robotics. The Centre's advisory committees are composed of eminent people from the industry to assure that the centres are 'industry driven' rather than Government or university driven to have projects of industries interest and to have completion of projects in set time frame.

Mining industries in Sweden, Australia, South Africa and the United States have also suffered the effect of third world competition for world minerals markets. To respond to the challenge, the Swedish industry, other than taking the immediate down sizing steps necessary, has launched an ambitious program called "Swedish Mining 2000", to assure survival of their mining industry into the 21st century through the application of innovative technology. They will be spending approximately $ 100 million over a 5 year period to achieve established programs objectives. The Swedish government will provide only 10 % of the program's cost; the rest will be provided by the mining industry and equipment manufacturers. Similar plans have been drawn up by AMIRA, (Australian Mineral Industries Research Association), for the Australian mining industry. Their development philosophy to meet their industry's needs however, differs considerably from the philosophy of some Canadian mining consortiums for the same purpose, as indicated in the quote from Hickson et al, their philosophy is to promote research leading to evolutionary changes in the industry in terms of the use of new technology. South Africa, although a developed country, is a unique situation because of labour wages which are comparable with wages in third world countries. Many in the United States consider mining a sunset industry.

In Canada, a private sector consortium called HDRK (Hard Rock) Ltd. was formed in 1983 to address the common technological development needs of Canada's four largest mining companies: Inco, Falconbridge, Noranda and Kidd Creek. (Kidd Creek is now part of Falconbridge Ltd.). Their development philosophy, contrary to AMIRA philosophy is to promote revolutionary changes in mining technology to meet their companies needs; they have an ambitious program to develop a continuous mining system to significantly increase mine productivity.

In 1985, CANMET began collecting information on research and development projects related to mining in Canada and disseminating this information in the form of an annual report, called the "Index of the Mining Technology Projects". As indicated, the Index is updated every year. In April 1984, the Federal Government signed with the Province of Manitoba the first of what has become a series of Mineral Development Agreements which have allowed for the joint funding of mine technology research programs. Table 1 indicates the funding level and projects by province for which CANMET has delivery responsibility. Present projects are concerned with the development of new technology in the areas of ground control, backfill technology, blasting, numerical modelling, mine infrastructure systems etc.

It is important to stress that many technologies in mining are not universally applicable because of the particular conditions encountered from mine to mine. Depending upon the size, grade and type of the ore body, its life and location, only certain technologies will be applicable. Recently, a new phrase has been coined to describe the situation where technology must be selected to meet particular conditions; called "appropriate technology". As an example, small mines with limited ore resources, small tonnage production and limited life expectancy will not be in a position to use a highly automated mining system or to attract the highly skilled people required for its operation. For such mines, an "appropriate technology" is probably one involving a moderate level of mechanized operation. Many in the mining industry have some difficulty with the concept "appropriate technology", but I think, it is valid for the present situation in the mining industry.

Con Mine in the NWT and Sigma Mine in Quebec, both of which have been in production for more than 4 decades represent examples where defining new more productive "appropriate technology" would be difficult. They have miles of openings and have been designed for exploitation using labour intensive technologies. If a similar size gold mine (a small mine) was opened in Quebec today, it would be designed on the basis of totally new technological concepts. The technologies would not be compatible or comparable. The transfer of most new technology to older mines would be economically difficult if not impossible.

CANMET is well aware of the often unaddressed research needs of small mines and plans to concentrate more of its energy towards addressing their needs. Small mines are increasingly important mineral producers in Canada particularly in the Province of Quebec. CANMET has already produced a manual for 'Estimating Preproduction and Operating Costs of Small Underground Deposits' to help small entrepreneurs. This manual has been particularly well received by the mining industry and is now widely used. Many of you have surely seen or used this manual.

The introduction of new technology in small mines implies a much greater need for them to carry out engineering studies. Such studies will involve establishment of productivity goals and possible methods of achievements, and the development of operational plans and goals. The introduction of new technology however, requires a level of expertise that many small mine staffs do not possess; experienced mining engineers knowledgeable in new mining technology, and its technological applications are required who can provide solutions to extremely complex problems.

A possible solution for small mines requiring the use of new technologies is joint projects involving several small mines with similar operations and problems and a research organization such as CANMET. Joint research projects involving CANMET have certainly been effective in the past in addressing industry problems in the area of ground support, ground control, communications, non-destructive wire rope testing, mining methods etc. The mines participating in these research projects however, were major mining operations. The thrust of these joint project was to adapt available technology to the particular requirements in order to permit changes to be made in the basic mining methods being used.

Technology induced changes in small mines are likely to be more evolutionary than revolutionary. That is changes will be introduced which improve the methods used to perform a certain task rather than eliminate the need for the task. Small mines by design tend to be labour intensive. That is not an indication of stone age or conservative thinking on the part of the mine designers but of economic reality. Small deposits cannot be economically exploited with big equipment, big openings and months of unprofitable preproduction development.

CANMET support is available to assist industry initiated research. In the case of small mines this support will probably take a different form than that provided to larger mines but is negotiable. The message I would like to convey to small mines is that CANMET exists and is receptive to joint research initiatives with them with a view to making small mines safer, more productive and more efficient.

Although it is not in CANMETs mandate to become directly involved in mine equipment development, it has funded a number of equipment development projects including development of a mini-scaler. In fact the prototype was tested in a Quebec mine. The latest production model is a very saleable unit; to achieve maximum mobility, it is powered by a diesel/electric hydraulic power system. The assistance of an operating mine is essential for the field testing of a newly developed equipment such as the mini scaler. The latest version of the scaler is shown in fig. 3. CANMET has also supported the development of accessory equipment for DTH drill control which will permit their automation. These retrofit accessories allow quick accurate setup of DTH drills, provides drill bit trajectory at 5 ft interval. At 10 ft depth it calculates projected hole deviation when the accessories are being used. If deviation is within preset limits, drilling continues otherwise the drill is shut down. The prototype accessories are presently being developed for commercialization. The drilling accessories control equipment is shown in fig. 4.

The Roger boring machine shown in fig. jj is an unique boring machine. It was developed by Machines Roger International Inc. of Val d'Or. It has been successfully used at Mines Bousqué to drive a raise. Both , provincial and Federal agencies, in part, have sponsored and funded its development.

Another piece of equipment that could be of importance to small and narrow vein mines in Quebec is now being manufactured and marketed by Teledyne in Canada. The equipment is built in Canada under licence from l'Equipemnt minier, Paris, France and is the smallest microscoop presently available on the world market. It is 85 cm to 160 cm in width with 600 kg or 1 cu yd capacity. The fig. pp illustrates the use of the microscoop in a narrow vein operation while fig. rr provides some indication of the size of the microscoop by comparison with the operators size. The microscoop can be converted to the smallest electrical/hydraulic powered drilling jumbo presently available (fig. gg) The microscoop in its two configuration provides all the equipment required for a complete cycle of drilling, blasting, loading and transportation in an opening 1.20 m wide. Its compact size and 85 cm width also makes it an essential tool for drilling and roof bolting. The microscoop has been designed with convenience of interchangeability in mind: the chassis remains the same but the drill and drill controls or bucket can be quickly added to change its function. It can drill holes of 26 to 45 mm diameter. The microscoop is more efficient than the scrapers it replaces; scrapers are notoriously inefficient when long scrapping distances are involved.

In the conclusion I would like to say that the Canadian mining industry has weathered a tough period and is emerging confident of its future. The confidence comes from defining clearly the actions necessary to survive and prosper in the 21st century and taking all necessary steps. The Quebec mining industry is playing its role in this regard, particularly with respect to small mines which are of particular concern to the province. As in the past, the mining industry find CANMET a willing partner in research ventures directed at improving the industry's competitive postion.