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ECONOMIC AND ENGINEERING PREREQUISITES FOR MODERNIZATION AND EXPANSION OF PLANTS IN THE COPPER INDUSTRY 1/

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1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO.

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SUMMARY

Based on current market studies, increases in the productive capacity of the copper industry will be needed to meet projected increases in world-wide consumption brought about by accelerated industrialization in the developing areas, improvement in standards of living, and population growth. This demand for increased production will be obtained by expansion and modernization of active mines and the development of new mines. Determination of where increases in production will come from, will be dependent upon a number of economic and engineering prerequisites.

The UNIDO objective of accelerated development of copper production in the developing countries can provide production required to establish and maintain stability in international markets. Expansion of production at existing properties can be an important alternative to developing production from low-grade copper deposits.

Because commitments to expansion or development of new resources are large enough to have a significant impact on the future success of mining enterprises, the reasoning for expanded production must be supported by sound research and economic analysis. Accurate projections of market conditions will provide the basis for proper timing. With favourable market projections, objective and systematic evaluation of the best alternate or alternatives will provide the basis for decisions and how to approach the increased production objective. The chosen alternatives must be compatible with short and long-term planning of the mining enterprise.

Incorporation of the most efficient equipment available in the expansion plan and thorough investigation of engineering feasibility are necessary to insure operational reliability of new and expanded facilities. Careful estimation of project costs is necessary to insure increased production with the most desirable return on the investment.

Determination of the ultimate potential and the best plan for exploitation of an ore reserve is accomplished through investigation of many mining plan variations and design plans covering varying time intervals and production rates. An approach to ore body development and mine planning used by Kennecott Copper Corporation for evaluating profit potential and economic limits is presented in this paper. This approach, which utilized the calculating power of the computer, can be used by any mining enterprise to assist in evaluation of increased production alternatives and as a guide to long-range and short-range mine planning.

Contents

Introduction

1. The significant role and contributions being made by the United Nations Industrial Development Organization in accelerating industrialization in developing areas is recognized as a forward-looking imaginative approach conceived to improve living standards throughout the world. Technical assistance directed to the development of copper production through expansion of existing mining properties and opening new ones can be an important activity of the organization. The relatively untapped resources of the emerging nations, if developed to full potential, can provide the means for improving the standard of living of such nations and offers the hope of a better future for millions of people.

2. The economic and engineering prerequisites for modernization and expansion of plants in the copper industry is much broader in scope and more general than engineering oriented papers comprising the balance of the programme. No single set of detailed criteria can be listed and applied to all situations. Therefore, this paper attempts to outline certain basic criteria for evaluating how, where, and when increased production can be achieved.

3. First, the reasoning for expanded production must be supported by sound economic analysis. Few commodities are more sensitive to fluctuations in supply and demand than copper. Relatively minor economic forces can have significant influence on international market conditions. The objectives of projects under consideration must be clearly developed through careful study and evaluation of those factors which prompt consideration of expansion. Accurate projections of market conditions will provide the basis for determining proper timing for introducing additional production.

4. With favourable market projections, alternatives such as expansion of existing production facilities versus development of new sources of production must be objectively and systematically evaluated. The chosen expansion alternative or alternatives must be compatible with short- and long-term planning for the entire mining enterprise. For example, mining ore bodies at a more rapid rate without planning for new sources of production could have serious impact on the long-term objectives of an enterprise. On the other hand, expansion of production at an operating property may be the most logical approach to maintaining or achieving production objectives over the short term until planned new production sources are developed.

5. Expansion may be prompted by the economics of a special situation. For example, expansion of existing facilities can provide a logical approach to reducing unit cost by virtue of higher production. This could be accomplished through more extensive utilization of capacity in existing facilities, modernization of equipment and installation of more efficient processes. In many cases, lead time for obtaining

increased production is lower with expansion of established properties. Likewise, capital costs per unit of increased production are often less than costs for development of new properties. In specific locations, expansion associated with modernization can actually extend the life of mining properties by reducing unit costs of production to a point that lower grade ore can be mined and processed at a profit. Complete replacement of existing facilities may not be the lowest cost approach. Likewise, additions in kind may not be the best alternative. The best approach may be somewhere between these two extremes. Thorough engineering and financial studies are primary prerequisites to effective decision making.

I. ECONOMIC PREREQUISITES

6. Commitments to expansion or new development programmes for increased production may be, in many cases, large enough to represent the future success or failure of an enterprise. Because of the financial risks involved, it is important to thoroughly evaluate all economic factors which can influence the final outcome. Some of the major economic prerequisites for increasing production are the following:

Capital investment

7. Expansion of production capacity requires large capital outlays. The use of capital at the most promising locations reduces risks and enhances the financial position of an enterprise. The matters of thorough economic evaluation followed by sound engineering become all the more critical when future sources of copper are considered. It must be assumed that major increases in production will come from known ore reserves presently considered as submarginal in value, or from similar sources yet to be fully evaluated. The alternative is expansion of existing properties. The activity of such nations as Japan, Great Britain and Sweden in foreign lands stems in large part from need to assure continuing supplies of minerals lacking in whole or in part domestically. The UNIDO objective to accelerate development of new mines in the developing areas of the world to offset the costs of mining the relatively low-grade copper deposits will assist the industry in paving the way for exploration in areas attractive for capital investment.

Market projections

8. Few commodities are as price sensitive to developments in various areas of the world as copper. Developments in the major copper producing areas such as Chile, the Congo, Zambia and the United States can have a significant influence on world

copper markets. A multitude of factors such as labour unrest, political change and fluctuations in economic activity, have their effect on copper price and may influence expansion decision. On the positive side, business and economic expansion also have their effects. Starting up a new mine or expansion of an existing property with equivalent processing capacity involves significant expenditure, therefore, the decision to expand production must be supported by a sound market study. It is reasonable to assume that significant future increases in copper production will be largely derived from development and exploitation of lower grade ore bodies and through expansion of production at existing properties. Objective projections of operating costs, selling price and business outlook are determining factors in decisions related to increased production and/or opening of new mining properties.

Consumption growth rate

9. Growth in consumption associated with industrialization in developing areas, improvement in general standards of living, military usage and increases in population may have some effect on eliminating or reducing possible oversupply conditions of the industry.

Production growth rate

10. The evident surplus capacity in the future may be only a theoretical one. Strikes, delays or interruptions in transportation, and potential decline in market prices associated with oversupply all decrease and, at times, eliminate the availability of this apparent surplus capacity. Factors influencing the extent of expansion are availability of capital, cost of capital, and operating expenses such as labour cost, material cost and overhead.

Labour, transportation, resources and taxes

11. In analysing the economics of a mining potential the cost of labour is a basic factor. It is relatively easy to cost. However, evaluation is more than a mere monetary matter. It should embrace the background of the labour force. Are workers competent, do they accept authority, can they be trained, do they respect and have aptitude for mechanical equipment? Escalation of labour costs over a period of years must be considered to evaluate profit potential of new or expanded mines. New plants must, therefore, compensate through incorporation of the most advanced technology to assure a profitable operation over the life of the mine.

12. Availability, dependability, and costs of transportation and utilities are also important factors in productivity. Water, electricity, gas, steam, communications, sanitation, waste disposal and other utilities must be carefully evaluated to determine impact on production costs. Future constraints on such items should be determined to insure against limitations which could be determining factors in planning.

13. Local taxes must also be considered in the economic evaluation of alternate approaches to expansion. The matter of local taxes is a complex subject which merits separate treatment.

II. ENGINEERING PREREQUISITES

Approach to expansion

14. Once the logic for expansion is established with the support of sound market projections the approach to expansion must be developed to provide the optimum return on the investment and optimum position relative to production. If market conditions indicate that increased production is warranted, economic analyses will largely influence where the increased production will come from. Increased production may come from one or more of three sources: (a) from existing mines, (b) from known but undeveloped ore bodies, and (c) from ore bodies as yet undiscovered. Selection of the best course of action involves complex analysis of the alternatives in terms of optimum application of capital consistent with production and profit objectives.

Determination of optimum production

15. It is essential to determine the optimum scale of operations. Too small a mine is simply not economical. In the absence of very high grade ore, 10,000 to 20,000 tpd, mines should be approached cautiously unless existing processing facilities can be made available or new facilities of economic size can be provided to handle production from a combination of mines. The size and shape of an ore body may not be prime determinants of the scale of operations. However, planning relative to mining methods and rates of ore production are prerequisites to design of processing facilities.

Ore body development and mine planning

16. The determination of the ultimate potential and best exploitation of an ore reserve is accomplished through investigation of many mining plan variations as well as to design plans covering varying time intervals and production rates. Traditional mine planning methods have been improved through application of computer technology to produce a more realistic calculation of ore reserves and mining plans. An approach used by Kennecott Copper Corporation for evaluating the profit potential and economic limits for existing mines can provide the basis for determining which approach to use for increased copper production at existing or new mines. The system was first applied as an aid in determining the economic potential of underdeveloped mineral deposits. The refined system has been modified and applied for pit-design applications

at active mines. The techniques used are not revolutionary but are an expansion of previous planning methods using the calculating power of the computer.

Research and investigation

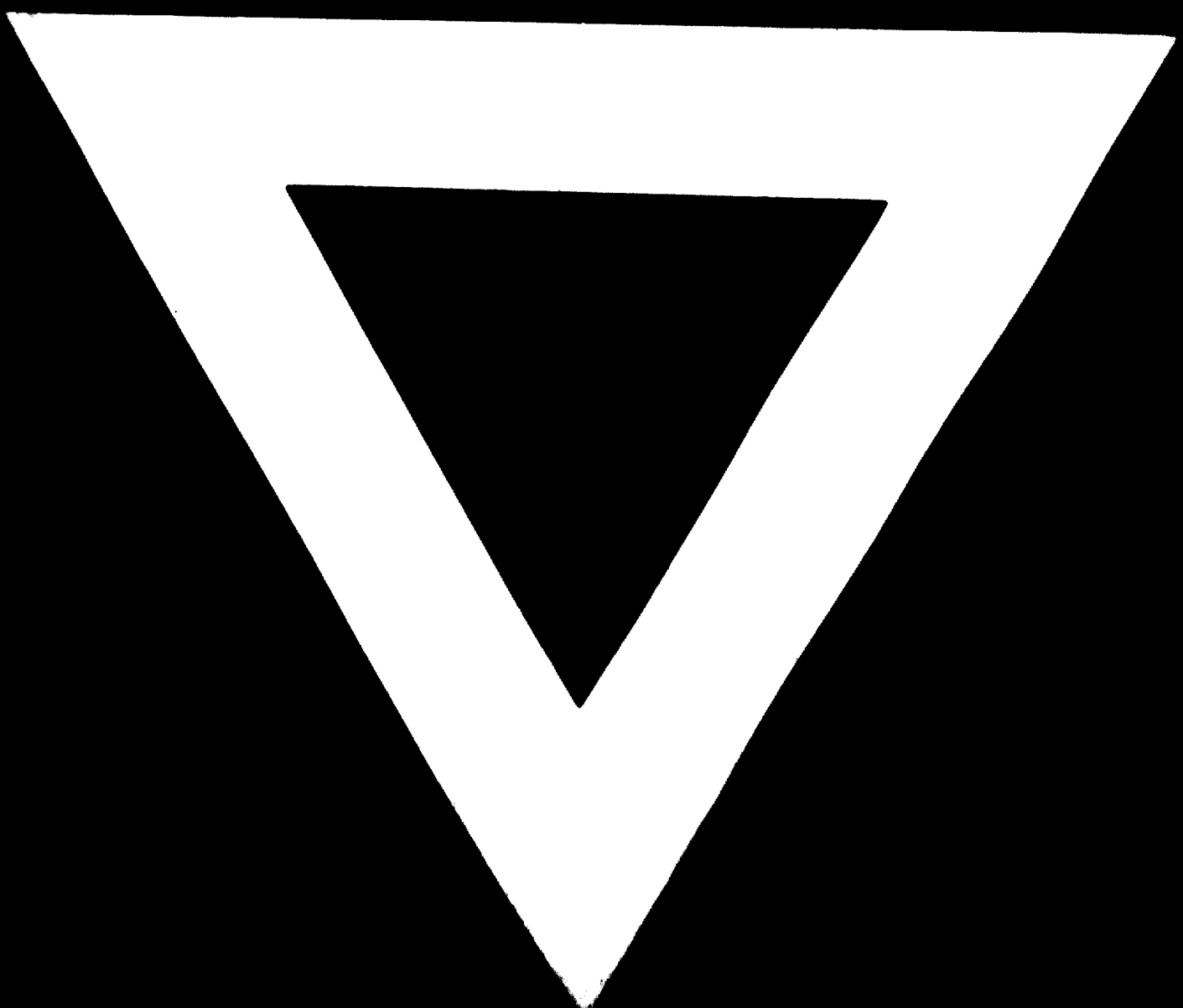
17. Process investigation and evaluation should include evaluation of primary engineering prerequisites to make proper decisions on the approach to expansion. These would include mineral ownership and rights, ore reserves, ore quantities, mining method, underground facilities, material handling methods and process equipment. Incorporation of the most efficient equipment available in the expansion plan is desirable from the standpoint of operating efficiency. It is advisable to use caution on installing or adopting new equipment or processes without adequate investigation and to use, if possible, pilot scale performance testing. There are many examples where major expenditures for new installations have not duplicated laboratory or performance tests. Thorough investigation of engineering feasibility to assure operational reliability is essential.

18. Expansion plans must be based on sound basic research. This research may have to be contracted out to reliable research organizations if not available internally. In either case, the precaution of outside confirmation of research findings is advisable. After determination of plans and processes, careful estimation of project costs for construction to meet expansion objectives must be determined and related to the economic prerequisites. Estimates for site preparation, construction materials such as concrete, steel work, equipment, piping, etc., labour man-hours, rental equipment costs, subcontract costs, direct costs, indirect costs and contingency would be included in this evaluation. Escalation of equipment and labour costs over the engineering and construction period can add substantially to project costs, and must be included in the contingency.

Project installation

19. The sequence for proceeding with construction must be planned to assure timely completion and minimum expenditure of funds. Critical path schedules and check lists are essential tools to complement the engineering plan. Engineering planning must include comprehensive evaluation of basic factors such as site, access and transportation, climate factors, ground conditions, utility availability, safety hazards, etc. Other items would include the source of construction labour, subcontractors available, sources of rental equipment and sources of materials. A check into national and local laws for permits and licences is required before the project is undertaken. Proper direction of engineering and construction is essential to insure that the increased production objectives are met. This direction is usually provided by a competent project installation team with full authority and accountability for

completion of the modernization or expansion within the appropriated funds, within the scheduled time allotment, and according to the engineering plans. The project cannot be considered complete until increased production is attained at prescribed production cost.



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