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A Computerised Approach to Teaching Mine Financial Valuation

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The main users of computerised financial evaluation tools in the mining industry are the mining investment analyst, the mine manager together with his financial manager and the mining student (undergruadate and postgraduate).

The mining investment analyst's needs mainly centre around the micro and macro aspects affecting the mining industry in general. The mine manager needs a tool to assist him with the planning, reporting and controlling of production, costs, efficiency, productivity and cashflow. For the mining student studying Financial Evaluation, the main need is for a computer program which will assist him in learning the basics of the subject.

This paper concentrates on the needs and objectives of the course Financial Mine Evaluation, the approach to which is presented. Emphasis is placed on the practical computing sessions and the role of the FCS-EPS package as a training tool.

Introduction

During their examinations, final year students in Mining Engineering at the University of Pretoria are obliged to orally defend the financial mine evaluations of the mines which they have designed. It became apparent that they did not have the necessary insight to do this successfully. A search for a suitable computer program which would support the learning process was considered necessary.

Such packages fall into two major categories of architecture. On the one hand there are spreadsheets such as VISICALC and LOTUS 1-2-3. These systems are relatively cheap and easy to use, but suffer the disadvantage of having both their modelling logic and data embedded in the same file. The alternative is a system such as IFPS or FCS-EPS which splits the model logic and data into separate files. This separation facilitates processing multiple sets of data via the same model. After detailed investigation of the alternatives it was realised that the FCS-EPS program was best suited to meeting mining students needs regarding learning the basics of financial mine valuation.

The package has been mounted on the University IBM mainframe. Students are afforded access to the system by means of terminals which are located in the Engineering Faculty.

The Financial Mine Evaluation course

After assessing the needs of the mining students, the objectives of the Financial Mine Evaluation course were defined, and the course content and method of presentation were established.

Needs

The following were identified as the primary needs of the course.

- teaching students the basics of mine financial evaluation
- illustrating how the different variables affect costs, income, cashflow and profitability over the life of the mine
- providing assistance to students when making investment decisions during their final year Mining Design course
- providing a financial model which could be used by the postgraduate student researching financial mine evaluation

Objectives of the course

At the end of the course, the student should be familiar with, and be able to apply to raw data, the following financial investment decision techniques and concepts, doing so by means of computer.

- Discounted cashflow techniques such as :
  - payback period
  - internal rate of return
  - net present value
- Feasibility studies
- Sensitivity analysis
- Risk analysis
- Effects of taxation
- Effects of inflation
- Exchange rate effects.

It is constantly remembered that the use of a computerised financial model is intended to supplement the process of learning Financial Mine Evaluation, and not to replace the more traditional teaching media.

Content of the course

The course consists of a series of lectures and practical sessions.

Lectures

The course is presented over 32 lectures each of forty minutes duration. The course is timetabled for the first semester of the final year in order for the student to be able to apply his knowledge during the second semester when the Mine Design must be submitted.

The initial five lectures cover the basic factors affecting mine evaluation, and the effect these have on the source and application of funds in the mining industry. Table 1 is constantly referred to throughout these five lectures.

In the following four lectures a practical example of a copper mine is discussed. Particular attention is given to the reporting of production and financial results, as well as to the presentation of five-year and life-of-mine plans.

Emphasis is placed on budgetary control and the monthly reporting of anomalies. This emphasis is achieved by the consideration of, and providing explanations for, the various items which are commonly found on a mines' monthly report. These items include data such as:

- development metres

INCOME (Source)	EXPENDITURE (Application)		
	Assets acquired (Investment)	Working costs	(cost of Sales)
Capital - equity - own funds - loans rec. - affiliate - foreign Ore reserve - volume - geological loss - pillar support - dilution - grade Plant - efficiency - recovery Product sold - raw material - upgraded - price - exchange rate Byproducts - road metal - sulphuric acid Other - interest earned - investments - royalty - farming - assets sold - letting	- property - equipment - infrastructure Leasing - property - equipment Loans granted interest paid Mining lease Tax	Production costs Main cost centres - Mining - Plant - Hostel - Administration - Engineering - Services - Engineering - Head Office - Prospecting Main elements - Salaries - Stores - Provisions	Selling costs Railage - Free on rail Shipping - Free on board - Cost, Insurance Freight - Harbour costs Storage Insurance Commission Smelting - losses Refining - losses Levy Analysis costs

Velocity of monetary circulation
(Working capital)
(Cost of sales)

INCOME - EXPENDITURE ⟶ CASH FLOW

Table 1. Factors affecting mine evaluation

- tons of ore milled
- kg of gold produced
- mining costs
- plant costs
- pumping and ventilation costs
- management fees
- sundry costs
- mining revenue
- non-mining revenue, etc.

Due to the complexity of the mine leasing and tax formulae applicable to the South African gold mining industry and the effect that this has on cashflow, lectures 18 to 24 cover this field extensively, with frequent reference being made to the prescribed textbook.[1]

The remaining lectures cover

financial prognosis together with financial and investment analysis. The adapted FCS-EPS software is used to perform feasibility studies as well as to consider sensitivity and risk analyses.

The lectures are supplemented by 7 three-hour sessions during which students are given the opportunity to practice their knowledge and skill in solving mine financial valuation problems by means of the computerised model.

Practical sessions

There exists a variety of financial models available and in use in the mining industry. The author found that students failed to understand these financial models when they were supplied in a ready-made form. For students to simply apply data to the model, without the modelling logic being understood, was felt to be an inadequate teaching exercise.

In an effort to overcome this problem, it was decided to let the students write out the logic for their models and then to let the computer perform the calculations from data supplied. The level of complexity of the students' input was progressively increased as the course progressed.

The practical sessions were sub-divided as follows:

Session 1

Having attended the preliminary nine lectures, the student is able to calculate manually the profit before tax of the copper mine case study mentioned earlier. The first practical session is therefore devoted to performing such a manual cashflow exercise based on data provided.

Session 2

The cashflow calculated in Session 1 is discussed. The students are then provide with an FCS-EPS logic file. This file contains all the statements which are required in order to import the neccessary data from an external data file. The calculation section of the logic file is, however, omitted and the students must complete this section using the knowledge learned during the earlier lectures.

For example, a statement has to be written creating a new variable 'tons of copper produced' which is the product of the input data items 'tons mined','percentage grade of the mill feed' and 'plant recovery efficiency'. The student must write a total of 24 such statements, culminating in a logic line which represents pre-tax mining profits of the operation.

Using these two files, i.e. the data file provided and the logic file as expanded by the student, the computer calculates the case study cashflow. The computerised answer is compared with that derived manually during Session 1.

Sessions 3 to 6

In the Republic of South Africa, tax calculations for base mineral mines are based on a percentage of profits, as is the case with non-mining companies. This is not so for gold mines. Furthermore, the tax formula for gold mines makes allowance for their age. Old mines, for example, are not expected to pay mining lease. The redemption of capital expenditure in older mines is also spread over the expected remaining life. Because of these, and other, complexities the four subsequent sessions are devoted to a gold mining financial model.

Session 3

The results of Session 2 are first discussed, emphasising the time-saving element introduced by using the computer.

During the previous sessions, the copper mine case study covered all the factors influencing the mining or production activities and the resultant source and application of funds. During Session 3 non-mining income and expenditure such as loan repayments, royalties and interest are brought into the exercise, in addition to tax considerations.

The student is again supplied with a logic file, the calculation portion of which has been omitted. He is expected to write statements covering the logic of production statistics, mining revenue, production costs and loan repayments. The end product of this process is a line calculating mining profit after interest payments and before tax. By creating a data file and linking it to the logic model the student is able to generate on the computer a pre-tax cashflow.

Session 4

The student must expand the same logic file which he was using during session 3 to include:

- Unredeemed capital balance
- Capital allowance
- State's share of profits
- Amount subject to lease
- Mining lease payable
- Taxable mining income
- Mining Tax payable
- Non-mining taxable income
- Non-mining tax payable
- Surcharges and levies
- Total tax payable
- After-tax profits

Additional data is provided, and the student runs the model again to create an after-tax cashflow.

Session 5

The student completes the logic file by adding coding to calculate:

- Net cashflow after capital expenditure
- Internal rate of return
- Net present value

These three indices must be derived in both current and real terms.

Session 6

At this stage the student has completed the financial model and is in a position to undertake sensitivity and risk analyses. In this manner he will be able to observe the effects on the life-of-mine financial position as a result of changes to the data.

Students are required to make changes to given variables such as gold price, capital expenditure, working costs and exchange rates, and to test the sensitivity of the model to these changes.

Session 7

The results of Session 6 are discussed. A menu-driven model is then made available to students, enabling them to experiment with the different funtions of the FCS-EPS program.

At the end of the final year undergraduates have to submit a design of a mine, illustrating its' financial potential. Making use of the skill and knowledge now at his disposal the student is able to develop a financial model for his particular mine, making use of the sensitivity and risk analyses which are integral parts of the FCS-EPS package.

Conclusion

At the latest examination of the subject Mine Design, it was found that students had a better grasp of the requirements of sound financial mine evaluation than was previously the case. Forcing the student to develop the logic for his financial evaluation model was the main factor in achieving such a level of understanding, enabling him to design a model best suited to his particular mine design. The hands-on approach applied in the use of the FCS-EPS program produced the required results.

Reference

1. STORRAR, C.D. - South African Mine Evaluation, 1981 Johannesburg, Chamber of Mines of South Africa. pp. 385-456.

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