

Accrual Accounting Concepts v Four-D Concepts in the Treatment of Costs

David Whittle

Qualifications: Bachelor of Business (Logistics and Transport Economics) Royal Melbourne Institute of Technology, Australia.
Experience: Co-Author of papers on 'Block Size Determination for Optimization of Coal Mines', 'Combined Pit and Blend Optimization' and 'Use of Three-D and GETOS (Russian) Mining Software'. Key developer of 'Single Order Blend Optimization Model for Three Springs Talc Deposit' at MISG 1996. Contributor to the Opti-Cut User Manual.
Currently: Business Manager - Whittle Programming Pty Ltd, Australia.

Abstract

Accrual accounting is universally used as the basic business financial reporting system. The idea behind the system is to match costs with revenues for particular activities, so that a true picture of the profitability of the activities can be obtained. The results of accrual accounting manifest themselves as the Balance Sheet, the Profit/Loss Statement and a variety of other historical business reports. The cost and revenue information required to perform pit optimization (FDOP) is different to that required for accrual accounting and the requirement for DCF Analysis (FDAN) is different again. This paper seeks to illuminate the difference, with particular reference to an Australian Accounting Standard for the extractives industry.

Introduction

The historical cost-based double entry accounting system was developed in Italy in the 12th and 13th centuries. The system, sometimes referred to as the 'System of Venice', spread with Italian merchants to the rest of Europe and to England and by the end of the 15th century, its use was very widespread. Records from the time showed sophisticated practices including deferrals and accruals, specialised journals and subsidiary ledgers. Although there have been changes in the system since the 15th century, the changes have been in the detail rather than in principle. Accrual accounting has become the dominant variant of the system.¹

The system has associated with it a large body of rules and conventions in the treatment of transactions, which, over time, became well entrenched and in 1547, Dutchman Jan Christoffels Ympyn related the compliance with these rules with the health and well-being of the bookkeeper:

"Thirdely the evill keyyng thereof, so vexeth the body, that it bredeth fevers & diseases" Ympyn, J., C., (1547)

I believe that that this can be translated into contemporary English as:

"Accrual Accounting Rules - OK!"

Accrual accounting is now so dominant in every day commercial life, that some of the rules and conventions have assumed the status of *self evident truths*, and the misapplication of these rules occurs in the mining industry. An example in the literature can be found in John Stone's and Peter Dunn's comments relating to the cut-off determination theory proposed by Ken Lane:

"...it is sometimes argued that developed ore should be treated if it will just pay for all subsequent treatment costs, since the sunk development costs are no longer relevant (e.g. Lane 1988; Taylor, 1972). Even though the cost to develop the specific stope or ton is indeed sunk by the time that ton is scheduled for mining, each ton treated in an on-going operation will be charged with the amount needed to develop its replacement. Although theoretically justifiable under a scenario where maximisation of output is the only concern of the operation, the idea that sunk costs somehow become irrelevant once they have been incurred is simply not true in the real world. Just because the mill has been built, it is ludicrous to imagine that the recovery of that cost is not relevant to the people who have put up the money to build it! Once the total pre-production expense has been recaptured through depreciation, previously non-economic ore may be profitable, but until this point in time is reached, depreciation and all on-going sunk costs must be included in the cut-off calculation."

¹ Refer to the Appendix for explanation of these terms.

Stone, John, G., and Dunn, Peter, G.,
(1996 P. 6-7)

Many would agree with the seemingly common sense approach taken by Stone and Dunn. It probably seems like common sense, because depreciation and amortisation cost concepts, which have been around for centuries, have become deeply entrenched in the thinking of anybody exposed to business accounting. Stone's and Dunn's criticism of Lane, K., F., (1988) is that it does not take account of depreciation, which is a tool used in accrual accounting. However, I believe their criticism is ill-founded, because Lane's model employs DCF Analysis, which is a project evaluation tool, not an historical accounting tool, and the rules of accrual accounting are not relevant.

The sort of confusion is common in relation to Whittle's Four-D which, like Lane's model, employs DCF Analysis, and also employs a pit optimization algorithm. However, I believe that most or all of the confusion can be cleared by examining the basic principles of accrual accounting, DCF Analysis and pit optimization.

Project Planning/Evaluation

Project evaluation and planning is a process which seeks the answer to the questions:

What is the most profitable design for this project?

On the basis of this most profitable design, should the project proceed?

It is convenient to think of the pit optimizer as an engine within the project evaluation process which partly answers the first question by maximising the difference between variable costs and variable revenues. The value of a project can thus be calculated as:

$$V = \text{SUM}(\text{variable_revenue} - \text{variable_costs}) + \text{non_variable_revenue} - \text{non_variable_costs}$$

The question as to whether or not the project should proceed is answered in the affirmative if the calculated value is positive.

The rules which govern which costs should be included can be stated simply:

All costs which vary according to the amount of waste, ore or product that is removed, processed or sold should be included in the pit optimization model, and any costs which do not so vary, should not be included.

All expenditure which was not included in the pit optimization model, except for the portion of expenditure which has already been committed and is irreversible, should be included in the project evaluation calculations.

Four-D is a relatively complicated project design and evaluation system. Because project value is measured as Net Present Value, it is necessary to know the mining sequence, so Four-D incorporates a hybrid scheduler / DCF Analysis package, and its use of pit optimization algorithm is used not only to determine the ultimate pit shape, but also to produce a guide for scheduling. However, the rules stated above in relation to which costs to include, are still valid.

Contrasting Accrual Accounting Requirements To Those Of DCF Analysis and Pit Optimization

Accrual Accounting is an historical accounting method. In contrast, DCF Analysis and pit optimization are both planning tools. Some basic characteristics of the methods are set out in Figure 1.

Characteristic	Accrual Accounting	Pit Optimization (FDOP)	DCF Analysis (FDAN)
Objective	Report on the past performance and current financial position of a business.	Find the pit with the maximum value given a model of the ore body, some forecast economic factors and a set of technical mining constraints.	Analyse and compare investment projects, taking into account the future earnings ability of money and the risk associated with the project.
Lifespan assumption	The business is ongoing.	Because the pit optimization algorithm cannot take account of time or sequence, the project is treated as if it were all mined and processed and sold in a single day.	The business might be ongoing or fixed length. If it is ongoing, the value of future business is accorded less weight, so business a long way into the future becomes virtually irrelevant.
Inflation	All cashflows are measured in nominal dollars. Inflationary factors exert themselves on the historical records of a business.	All cashflows are measured in today's dollars (i.e. independent of inflation).	All cashflows are measured in today's dollars (i.e. independent of inflation).
Value of money (changes in time other than due to inflation)	Past and present dollars are considered. The value of past dollars is the same as the value of present dollars in the financial records.	Present dollars and future dollars are considered. The pit optimization algorithm cannot take account of time so all dollars are attributed the same value.	Present dollars and future dollars are considered. Future dollars are attributed a lower value than present dollars.
Fixed and Variable Costs	Fixed and variable costs are included.	Only variable costs are considered in pit optimization.	Fixed and variable costs are included.
Past, Present and Future Costs and cashflows	Past and Present costs are included. Past and present cashflows which represent future costs can be accrued to future periods through the use of amortisation.	Only future costs are considered.	Only future costs are considered.
Doctrine of Conservatism	Analogous to the engineer's factor of safety in design, in the face of uncertainty, accountants are inclined to underestimate income and overestimate costs, in order to protect shareholders from their own rapacity for dividends. Gilman, S., (1939).	Conservatism can be built into technical parameters, such as resource estimates, pit slope constraints and costs, all of which will affect the pit design, but there is nothing inherent in the pit optimization algorithm which generates any sort of bias.	Conservatism is dealt with explicitly by the Risk Adjusted Discount Rate.

Figure 1: Characteristics of the different methods

The Australian Accounting Standard - AAS 7 (11/89), which is documented in AARF (1989), sets out the manner in which accrual accounting should be applied in relation to a mining operation. The objective is to achieve proper matching of revenues and expenses using the "area of interest method" and from an historic perspective. Expenses can be written off, carried forward and/or amortised on a production or time basis. In the case of anticipated cash flows, for example, the cost of restoring an area on cessation of mining, the cash flow can be provided for at the time that the expense is said to have been incurred.

Below is a summary of the cost categories and their preferred treatment under AAS 7, along with the preferred treatment for Four-D.

Exploration and evaluation costs where no discovery is made

AAS 7 Accounting

Write off.

Pit Optimization (FDOP)

Not Applicable - It does not vary in accordance with the amount of waste or ore that is removed or processed.

DCF Analysis (FDAN)

Not Applicable - It is committed and irreversible.

Exploration and evaluation costs, where it is unclear at the end of the reporting period as to whether or not a mine will be developed

AAS 7 Accounting

Carry forward.

Pit Optimization (FDOP)

Same treatment as for *Exploration and evaluation costs where no discovery is made*.

DCF Analysis (FDAN)

Same treatment as for *Exploration and evaluation costs where no discovery is made*.

Exploration costs where it has become apparent that mining will proceed

AAS 7 Accounting

Carry forward / amortise².

² Under AAS 7 amortisation should be done on a production output basis (e.g. \$/gram of gold produced), unless, under the circumstances, a time basis is more appropriate. Amortisation charges form part of the cost of production.

Pit Optimization (FDOP)

Same treatment as for *Exploration and evaluation costs where no discovery is made*.

DCF Analysis (FDAN)

Same treatment as for *Exploration and evaluation costs where no discovery is made*.

Cost of acquiring leases or other rights of tenure

AAS 7 Accounting

Classify as exploration, evaluation or development costs depending on the circumstances.

Pit Optimization (FDOP)

Not Applicable - It does not vary in accordance with the amount of waste or ore that is removed or processed.

DCF Analysis (FDAN)

If the cost is contingent on project start up, then it should be included. If the cost has already been committed, then the extent to which the cost should be included will depend on the likely resale value of the lease, should you decide not to proceed with the mining project. The likely resale value represents an opportunity cost; if the project proceeds, you will forego the resale value. Inclusion of the contingent lease acquisition costs in the DCF model is important if you are using the analysis to decide whether or not to proceed with the project. However, if you are using DCF Analysis to compare alternative designs and long term schedules, then the inclusion of the cost in the model is not important, because it will not affect the rankings of the alternatives.

Development Costs

AAS 7 Accounting

Carry forward / amortise.

Pit Optimization (FDOP)

Not Applicable - It does not vary in accordance with the amount of waste or ore that is removed or processed.

DCF Analysis (FDAN)

If the cost is committed and irreversible, it should not be included.

Construction Costs - in the nature of depreciable assets

AAS 7 Accounting

Depreciate in accordance with AAS 4.

Pit Optimization (FDOP)

If one of the following conditions prevails, then it can be said that the cost varies in accordance with the amount of waste or ore which is removed or processed:

1. The asset will need to be replaced during the life of the mine.
2. The resale value of the asset decreases in relation to time or to tonnes throughput.

The cost per tonne of waste or per tonne of ore should be calculated and included in the model.

DCF Analysis (FDAN)

If the cost has been explicitly handled in FDOP, the cost will be automatically carried over into the DCF Analysis model, so do not enter the cost again. The only exception to this rule is that, if you have had to model time based costs in FDOP as throughput costs, then FDAN allows you to re-enter the time based costs explicitly and reverse out the costs built into the pit optimization model.

If the cost has not been included in the pit optimization model, its inclusion in the DCF Analysis model will depend on the manner in which the resale value of the asset changes over time.

If the resale value is zero at any time (as would be the case for the concrete foundations for a processing plant), then the cost should be included as a single negative cashflow, but only if the expenditure has not yet been committed.

If the resale value decreases over time, then the amount by which the value decreases in each period should be applied in each period.

Construction Costs - not in the nature of depreciable assets

AAS 7 Accounting

Treat in the same way as development costs. That is, carry forward / amortise.

Pit Optimization (FDOP)

Same treatment as for *Construction Costs - in the nature of depreciable assets*.

DCF Analysis (FDAN)

Same treatment as for *Construction Costs - in the nature of depreciable assets*.

Continuing Development (the Standard does not discriminate between development of new resources/reserves or the upgrading the categories of existing resource/reserves)

AAS 7 Accounting

Amortise.

Pit Optimization (FDOP)

If the continuing development relates to potential new resources in the area of interest, then the cost should be excluded. If the continuing development relates to upgrading the categories of existing resources, the cost should also be excluded, although this issue is far less clear cut. It could be argued, for example, that if the pit produced by FDOP includes, some Indicated Resources, then extra costs will be incurred in relation to that ore to improve the estimate category to Measures Resource. However, I do not believe that this would be an appropriate treatment of the uncertainty associated with Resource and Reserve estimates and it is beyond the scope of this paper to discuss the issue in detail. Interested readers should refer to Hanson, N., (1995).

DCF Analysis (FDAN)

As for Pit Optimization.

Operation Costs

AAS 7 Accounting

Write off.

Pit Optimization (FDOP)

Costs should be categorised as mining, processing or selling costs. Within those categories, the costs should be categorised as either throughput based costs or time based costs. Throughput based costs can be applied directly. Time based costs must be converted to throughput based costs by dividing the cost by the period throughput which limits the mine life.

If the limiting factor in the mines production is the processing throughput, then all time based costs should be divided by the period processing throughput limit and assigned as a processing cost. Similarly, if the limiting factor is the mining capacity, then all time

based costs should be converted to mining costs. If the limiting factor is the amount of product that can be sold in each period, then the time costs should be converted to selling costs.

DCF Analysis (FDAN)

If the cost has been explicitly handled in FDOP, the cost will be automatically carried over into the DCF Analysis model, so do not enter the cost again. The only exception to this rule is that, if you have had to model time based costs in FDOP as throughput costs, then FDAN allows you to re-enter the time based costs explicitly and reverse out the costs built into the pit optimization model.

General and Administrative Costs

AAS 7 Accounting

Allocate only to the extent that the costs can be related to operational activities in the area.

Pit Optimization (FDOP)

General and Administrative costs that stop if mining, processing or selling stop, should be converted to throughput based mining, processing or selling costs. If the costs are not dependent on the project commencement or cessation, then they should not be included.

DCF Analysis (FDAN)

If the costs are not dependent on the project commencement or cessation, then they should not be included.

General and Administrative costs are generally time based rather than throughput based. If you have had to model time based costs in FDOP as throughput costs, then FDAN allows you to re-enter the time based costs explicitly and reverse out the costs built into the pit optimization model

Amounts received and subsidies in relation to exploration, evaluation, development or production

AAS 7 Accounting

Offset against the expense to which the payments or subsidies apply.

Pit Optimization (FDOP)

Offset against the expense to which the payments or subsidies apply.

DCF Analysis (FDAN)

Offset against the expense to which the payments or subsidies apply.

Restoration Costs

AAS 7 Accounting

Shall be provided for at the time of the activities to which the restoration is related and shall form part of the cost of the respective phase of operation.

Pit Optimization (FDOP)

As with AAS 7, restoration costs should be attributed to exploration, evaluation, development, construction or operation. If attributed to exploration, evaluation, construction or development (outside the pit) they should be treated as shown above for these categories. If the costs relates to operation, and the cost is related to the throughput of waste or ore, then the cost should be included on a throughput basis.

DCF Analysis (FDAN)

If the cost has been explicitly handled in FDOP, the cost will be automatically carried over into the DCF Analysis model, so do not enter the cost again. The only exception to this rule is that, if you have had to model time based costs in FDOP as throughput costs, then FDAN allows you to re-enter the time based costs explicitly and reverse out the costs built into the pit optimization model.

Conclusion

When using Pit Optimization and DCF Analysis techniques, care should be taken to avoid incorrectly applying accrual accounting rules to the calculation of costs. This can be achieved by referring back to the objectives and characteristics for the different methods.

The rules which govern which costs should be included are:

1. All costs which vary according to the amount of waste, ore or product that is removed, processed or sold should be included in the pit optimization model, and any costs which do not so vary, should not be included.
2. All expenditure which was not included in the pit optimization model, except for the portion of expenditure which has already been committed and is irreversible, should be included in the project evaluation calculations.

References

- AARF, 1989, *Accounting for the Extractive Industries* - Australian Accounting Standard AAS 7 (11/89), Australian Accounting Research Foundation, Caulfield (Melbourne).
- Colditz, Bernard T., Gibbins, Ronald, W., et. al, 1976, *Australian Accounting - Second Edition*, McGraw-Hill Book Company, Sydney.
- Gilman, S., 1939, *Accounting Concepts of Profit*, Ronald Press Company, New York, Cpt 15, quoted in Henderson, S., and Peirson, G., 1979, *An Introduction to Financial Accounting Theory*, Longman Cheshire, Melbourne, P. 54.
- Hanson, N., 1995, *The Big Picture: A Safer Future Using Lerchs-Grossmann Pit Optimization Linked to Cash Flow Analysis*, Optimizing With Whittle Conference, Perth.
- Lane K., F., 1988, *The Economic Definition of Ore*, Mining Journal Books, London.
- Stone, John, G., and Dunn, Peter, G., 1996 *Ore Reserve Estimates in the Real World*, Society of Economic Geologists, Colorado, P. 6-7.
- Ympyn, J. C., 1547, *A Notable and very excellent woorke, expressing and declaryng the maner and forme how to kepe a boke of accomptes or reconynges... Translated... out of Frenche into Englishe* (Richard Grafton, London), quoted in Henderson, S., and Peirson, G., 1977, *An Introduction to Financial Accounting Theory*, Longman Cheshire Melbourne, P.21

Appendix - Some Accounting Terms Explained

There are countless books available which contain excellent explanations of accounting and accounting terms, ranging from High School and University text books, to Encyclopaedia. However, on the assumption that many of the readers of this paper would not have ready access to such texts, I have included my own brief explanation.

Accounts

The accounts of a business are a record of the past financial performance and present financial position of the company. The words *Accounts* or *Accounting* are often prefixed by the words *Historical*, *Accrual*, *Double-Entry* and *Cost-Based*. These are not representative of mutually exclusive accounting methods. Each term describes an aspect of

accounting which needs to be highlighted depending on the context in which the term is used. The vast majority of businesses in first-world countries use historical accounting systems which employ Accrual, Double-Entry and Cost-Based Accounting methods.

Balance Sheet

The Balance Sheet is a report that shows the financial position of a business at a given point in time. The report lists the totals of all the Asset, Liability and Capital Accounts and must demonstrate that the basic equation; Assets = Liabilities + Capital is obeyed.

Cost-Based Accounts

The value of items is based on the cost of the items. For example, a shop may buy stock worth \$100 that it expects to eventually sell for \$150. The stock is recorded in the accounts as having a value of \$100, being the cost, rather than the expected sales value of \$150. Not until the item is actually sold is the value of \$150 taken up in the accounts, being attributable as \$100 for the cost of goods sold, and \$50 profit.

Depreciation and Amortisation

Depreciation is one of the tools available to the accountant to accrue costs. If a fixed asset, lets say a truck with a working life of 5 years, is purchased by a company, the purchase is first brought to account as an asset. Then, every year, an accounting entry is made to reduce the value of the asset and allocate the reduction as a *depreciation expense*. By this method, the cost of the asset is distributed over the working life of the asset and at any point in time, the Balance Sheet shows *the book value* of the asset. The book value of an asset is really defined by the method by which it is calculated and it would not be correct to say that it represents the resale value of the asset. A useful analogy is given in Colditz, Bernard T., Gibbins, Ronald, W., et. al, (1976, P.407):

“It is convenient to think of a fixed asset as a bundle of services to be received by the owner over a period of years. Ownership of a delivery truck, for example, may provide about 100 000 kilometres of transport. The cost of the delivery truck is customarily entered in a fixed asset account entitled Delivery Truck or Delivery Vehicles which, in essence, represents payments in advance for several years of transport

services... As the years go by, these services are used by the business and the cost of the fixed asset is gradually transferred into depreciation expense.”

Amortisation is similar to depreciation, but generally it is applied to intangible assets such as good will, or to prepaid expenses. An example of a prepaid expense would be the cost of building a haul road. The expense of building the haul road is incurred in early years, but the utility of the road is enjoyed throughout the life of the mine. However, building of the haul road would generally not be regarded as an asset in the same way as a truck is regarded as an asset. The cost of building the haul road is brought to account as a special type of asset, and every year an account entry is made to reduce the amount of prepaid expense remaining and to allocate it to the *amortisation expense* account in that period.

The ‘ongoing business’ concept has important implication in relation to depreciation and amortisation. That is, that the period over which depreciation and amortisation is charged over, can be set independently of the life of the business. The ‘conservative’ concept also has implications. Nobody can be sure of the exact working life of a piece of equipment. If for example, the expected working life of a piece of equipment ranged between 5 - 8 years, most accountants would be inclined to depreciate over 5 years. This means that the business will expense the item over five years. If the life of the item turns out to be longer than 5 years, then the accountant will have overestimated the cost in the first 5 years. However, this is consistent with the conservatism concept of accounting.

Double Entry Accounting / Bookkeeping

The double entry accounting system is based on the following basic principals:

The accounts are kept from the point of view of the business as an entity separate from the owners of the business.

The net worth of the business equals the assets of the company, less the liabilities of the company, and the net worth is equal to the capital of the owners. The basic equation is $Assets = Liabilities + Capital$.

In order to maintain the basic equation, an increase in Assets must be associated with an equal increase in Liabilities or in Capital, and a decrease in Assets must be associated with an equal decrease in

Liabilities or Capital. By convention, the equation is maintained by the use of two columns for every account, the left one being labelled Debit or Dr. (from the Latin ‘he owes’) and the right one being labelled Credit or Cr. (from the Latin ‘he trusts’). If ever an entry is made in a Debit column of an account, there must also be an entry made in the Credit column of another account. For example, *cash at bank* is an asset, whereby the bank owes money to the business. If a Debit entry is made to the Asset account called *cash at bank*, this indicates that there has been an increase in the amount that the bank owes the business; an increase in the asset of the business³. A corresponding Credit entry must be made to another account to maintain the basic equation. The account this Credit entry is made to will depend on the nature of the transaction. Some simple examples are given below:

Money was received as seed capital from the owner of the business.

Dr. Assets (Cash at Bank)
Cr. Capital

Money was borrowed from a friend to finance the business and deposited in the bank account.

Dr. Assets (Cash at Bank)
Cr. Liabilities (Loan from Friend)

A truck is sold (at its book value) and the proceeds of the sale are deposited in the bank account

Dr. Assets (Cash at Bank)
Cr. Assets (Trucks)

The accounts discussed so far are all present in the Balance Sheet, which is a report that represents the financial position of the business at a given point in time. However, the Balance Sheet says nothing about how the business got to where it is. For that, a

³ Please note that when a business receives an account statement from the Bank, the Bank is presenting the state of the account *from the Bank’s point of view*, so if the account is *in Credit*, from the Banks point of view, this indicates that *he trusts* (*he* being the Business) the Bank with the money. If the accounts is *in Debit*, this indicates that *he owes* the money to the Bank. When the money is viewed *from the point of view of the Business*, the Debits and Credits are reversed. Money in the Bank is represented in accounts of the Business as a Debit balance because *he owes* (*he* being the Bank) money to the Business. Money owed to the Bank is represented by a Credit balance because *he trusts* the Business with the money.

different report and some more accounts are required. The Profit and Loss Statement summarises two other types of accounts; Revenue and Expenses. It may be useful to think of Revenue and Expense Accounts as subsidiary to the Capital account, because at the end of each financial period, they are totalled up to determine the profit or loss for the period and allocated to the Capital account. Earning income corresponds to an increase in Capital, so income is represented in the accounts with a Credit entry to the Revenue Account. Incurring a cost corresponds to a decrease in Capital, so a cost would be represented in the accounts by a Debit entry to the Expense Account.

In practice, a business may maintain hundreds of accounts in its General Ledger, each one allocated for particular types of transactions. However, each and every account will fall into one of the categories; Assets, Liabilities, Capital, Revenue or Expenses. Its position in the General Ledger, and its position in the Balance Sheet or Profit and Loss Statement will be determined accordingly.

Historical Accounts

Records which show the historical performance of a business and its financial position at given points in time.

Profit and Loss Statement

The Profit and Loss Statement lists and totals all Revenue and Expense Accounts. The difference between Revenue and Expenses is the Profit (or loss), which is allocated to the Capital account.



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