Part 9

Capital investment appraisal and business strategy

Chapter 24

Capital investment appraisal

REAL WORLD CASE

This case study shows a typical situation in which management accounting can be helpful. Read the case study now but only attempt the discussion points after you have finished studying the chapter.

John Armitt, chief executive of Network Rail, the 'not for dividend' successor to Railtrack as owner of the UK rail infrastructure, does not expect an ongoing review of the industry's performance payment system to produce any significant changes.

'The first half of 2004/5 marked the start of the new five-year regulatory period, which has put the company on a sound financial footing. Our new investment appraisal procedures are ensuring greater efficiency and maximising the effectiveness of every pound in the ground,' said Armitt.

Source: Network Rail's Armitt sees no change to performance payment system AFX Europe (Focus); 26 November 2004.

Discussion point

What questions would you ask in appraising investment in a railway track or a railway station?

Contents

Learning outcomes

After reading this chapter you should be able to:

- Explain the purpose of capital investment appraisal and the role of the management accountant.
- Explain the payback method and calculate the payback period.
- Explain and calculate the accounting rate of return.
- Explain and calculate the net present value of a project.
- Explain and calculate the internal rate of return of a project.
- Explain how capital investment appraisal is used to choose from mutually exclusive projects.
- Explain which methods of capital investment appraisal are encountered in business practice.
- Explain the control processes applied to investment projects.
- Explain how advanced manufacturing technologies lead to a demand for new ways of evaluating investment projects.

24.1 Purpose of capital investment appraisal

The word 'capital' can have more than one meaning in accounting. In financial reporting in particular it is used to denote the finance provided to the business by owners and long-term lenders. Economists use the term 'capital' to refer to the fixed assets and working capital of a business which are purchased with the money provided by the owners and lenders. This chapter uses the term 'capital' in a manner similar to that used by the economists.

When the managers of a business make plans for the long term they have to decide whether, and how much, to invest in **fixed assets** and **working capital** to maintain or increase the productive capacity of the business. They will usually be faced with choices of projects available, each requiring a different type of investment, and only a limited amount of finance available. They have to ask themselves a number of questions, including:

1 How many of the proposed projects are worth undertaking?
2 How much finance, in total, should we commit to new projects?
3 Where should the finance be obtained?
4 After the event, was the investment in the proposed project successful?

These questions cross an academic spectrum of study which begins in management accounting and ends in finance. The first and fourth of these questions are normally dealt with in management accounting books, while the second and third form the focus of finance books. Some books in either discipline will attempt to deal with all the questions. This chapter focuses on the first and fourth questions. It explains techniques that can be applied to evaluate 'appraise' an investment project in order to decide whether it is worthwhile to start the project.

Definition

Capital investment appraisal is a process of management accounting which assists management decision making by providing information on the investment in a project and the benefits to be obtained from that project, and by monitoring the performance of the project subsequent to its implementation.

24.1.1 The role of the management accountant in capital investment appraisal

The management accountant's role was set out in Chapter 16 as **directing attention**, **keeping the score** and **solving problems**. In **capital investment appraisal** it is the role of **directing attention** which is important. Information about proposed capital projects must be presented in a way which will direct management's attention towards the significant information for decision-making purposes. There will most probably be problems to solve in terms of gathering and presenting the information. After the project is implemented there will be a **score-keeping** aspect in terms of comparing the actual outcome with the plans and expectations.

This chapter concentrates on the techniques of presenting information so as to direct attention to the significant aspects of the capital project for decision-making purposes. It concludes with an explanation of the retrospective evaluation of a project by a post-completion audit.

24.1.2 The assumptions adopted

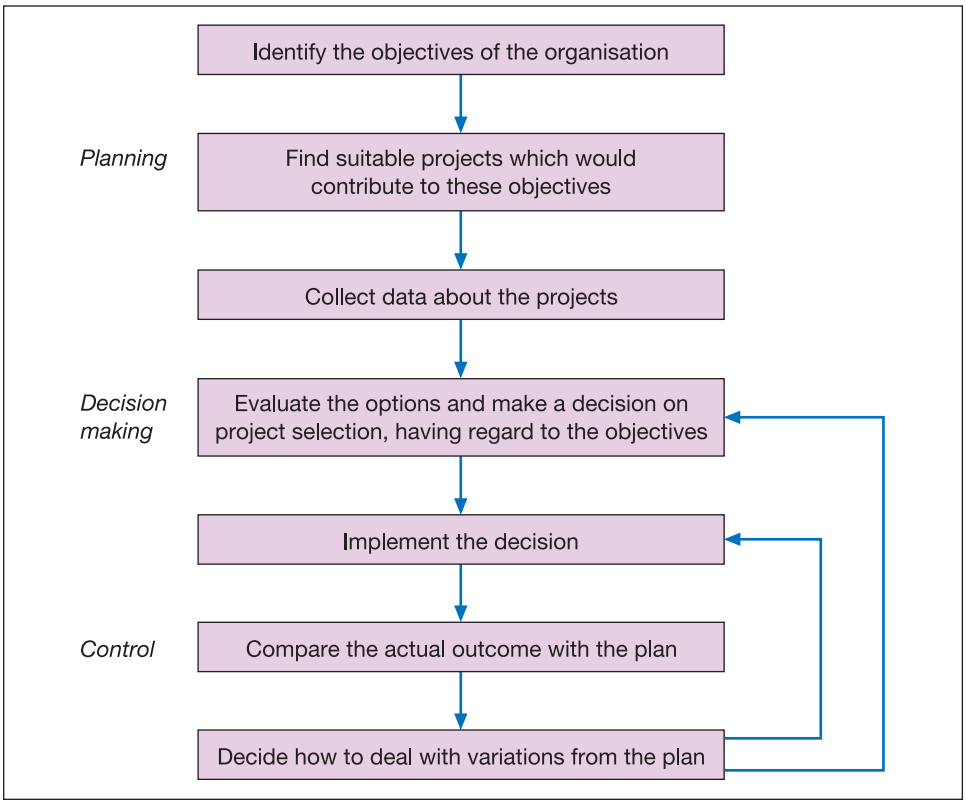
This chapter makes an assumption that all future cash inflows and outflows of a long-term project may be predicted with certainty. It also assumes that there are no taxes and there is no inflation to cause prices to increase over the life of the project. For

some of the calculations in the chapter there is an assumption that all cash flows take place on the final day of an accounting period. Making assumptions of this type may seem a rather unrealistic starting point, but it is necessary to do so in order to analyse the principles of capital investment appraisal without having too many real-world complications crowding in.

24.1.3 Making a decision on a capital investment

Chapter 16 contains a specification of the processes of **planning** and **control** which are necessary for a systematic approach to making an investment decision in locating a new retail outlet. In general terms, that process is as shown in Exhibit 24.1.

Exhibit 24.1
Planning and control for a capital investment decision



To be successful the business must first of all discover projects which have the potential for success. All the management accounting in the world will not create a successful project. The successful entrepreneur is the person who has the flair and imagination to identify projects and to see how they might successfully operate. The role of management accounting, through the **capital investment appraisal** process, is to ensure that the excitement of creating new investment opportunities does not cause management to lose sight of the need to meet the organisation's objectives.

24.1.4 Selecting acceptable projects

Suppose there has been a meeting of the board of directors of a company at which the managing director has said: 'We want to ensure that any cash we invest in a project comes back as soon as possible in the form of cash flows which give us a profit overall and provide the cash to reinvest in the next project.'

A second director has replied by saying: 'It's fine for you to talk about cash flows but the outside world judges our success by our profit record. I would like to see us choosing projects which maximise the return on assets invested in the project.'

A third member of the board has joined in with: 'I agree with the cash flow perspective but I want to be sure that, at the minimum, we cover the interest charges we have to pay on the money we borrow to finance the project. Ideally, there should be cash flows generated which exceed the cost of borrowing, so that we have surplus funds to use for investment in further projects or for increasing dividends to our shareholders.'

Reading carefully what each has said, it is apparent that there are similarities and differences in the targets they would like to set. They are all looking to cash flows from the project, but the first director is emphasising the speed of collecting cash flows, while the second director wants to convert cash flows to profit by deducting depreciation, and the third director is more concerned about the amount of cash flows in total and whether they provide a surplus after covering all costs.

Management accounting can provide information for **capital investment appraisal** purposes which would satisfy the criteria set by any one of the three directors, but there would remain the question as to which of the three directors is using the best approach so far as the business is concerned. Four methods of capital investment appraisal will now be explained. These are: the **payback** method, the **accounting rate of return**, the **net present value** method and the **internal rate of return** method. Each management accounting technique will be described in turn and the advantages and disadvantages of each will be discussed.

Activity 24.1

Decide now which of the three directors you think has the most desirable approach and why you think that way. Then monitor the development of your views as you read the chapter.

24.2 Payback method

24.2.1 Method of calculation

The first director wanted cash invested in a project to come back as quickly as possible in the form of cash flows. To test whether this objective has been met by a capital project, the payback method of project appraisal is used. It provides a calculation of the length of time required for the stream of cash inflows from a project to equal the original cash outlay. The most desirable project, under the payback method, is the one which pays back the cash outlay in the shortest time. Data are set out in Exhibit 24.2 which will be used to illustrate all the capital investment appraisal methods explained in this chapter. An illustration of the payback calculation is provided in Exhibit 24.3, and from this table of calculations it may be seen that project A offers the *shortest* **payback period**. Thus if the most important measure of success in investment is the recovery of the cash investment, then Project A is the preferred choice. Project C is next in rank and Project B is the least attractive.

Definition

The payback method of project appraisal calculates the length of time required for the stream of cash inflows from a project to equal the original cash outlay.

The **payback period** is the length of time required for a stream of net cash inflows from a project to equal the original cash outlay.

Exhibit 24.2

Data for illustration of methods of capital investment appraisal

Data

A haulage company has three potential projects planned. Each will require investment in two refrigerated vehicles at a total cost of £120,000. Each vehicle has a three-year life. The three projects are:

A Lease the vehicles to a meat-processing factory which will take the risks of finding loads to transport and will bear all driver costs for a three-year period. Expected net cash inflows, after deducting all expected cash outflows, are £60,000 per annum.

B Enter into a fixed-price contract for three years to carry frozen foods from processing plants in the UK to markets in Continental Europe, returning with empty vehicles. This will require employing drivers on permanent contracts. Expected cash inflows, after deducting all expected cash outflows, are £45,000 per annum.

C Employ a contracts manager to find loads for outward and return journeys but avoid any contract for longer than a six-month period so as to have the freedom to take up opportunities as they arise. Drivers will be hired on short-term contracts of three months. Expected cash inflows, after deducting all expected cash outflows, are £40,000 in Year 1, £70,000 in Year 2 and £80,000 in Year 3.

Exhibit 24.3

Calculations for payback method

Cash flows	*Project A*	*Project B*	*Project C*
	£	£	£
Outlay	120,000	120,000	120,000
Cash inflows, after deducting all outflows of the year			
Year 1	60,000	45,000	40,000
Year 2	60,000	45,000	70,000
Year 3	60,000	45,000	80,000
Payback period	2 years	2.67 years	2.125 years
(expressed in years and months)	*2 yrs 0 mths*	*2 yrs 8 mths*	*2 yrs 1.5 mths*
Workings	$60 + 60 = 120$	$45 + 45 + \frac{30}{45}$	$40 + 70 + \frac{10}{80}$

24.2.2 Impact of uncertainty in real life

This calculation assumes certainty about the cash flows predicted for each project. Hopefully, as you were reading the conditions of the three different contracts set out in Exhibit 24.2, you had some thoughts about the relative commercial risk of each project and the risks attached to the cash flows. In this chapter we do not make allowance for the relative risks of each project, because we make an assumption of certainty of predicted cash flows but, in real life, Project C would be regarded commercially as the high-risk option, while projects A and B provide greater certainty through having contracts in place for the three-year period. Of these two, project B looks the less attractive but leaves opportunities for casual earnings if loads can be found for the return journey.

24.2.3 Usefulness and limitations of the payback approach

The **payback** method of **capital investment appraisal** is widely used in practice, possibly because it is relatively painless in its arithmetic. Furthermore, there is a reflection of commercial realism in concentrating on projects which give early returns of cash flow. That may be important to organisations which face cash flow constraints. It may also be seen as a cautious approach to take where product markets are uncertain and it is difficult to predict the longer-term cash flows expected from a product.

One major limitation of using the payback method of capital investment appraisal as described here is that it ignores the fact that investing funds in a long-term project has a cost in terms of the interest charges on borrowed funds (or interest forgone when money is tied up in fixed assets). Economists refer to this interest cost as the **time value of money**. This is the name given to the idea that £1 invested today will grow with interest rates over time (e.g. £1 become £1.10 in one year's time at a rate of 10%).

Definition

The **time value of money** is the name given to the idea that £1 invested today will grow with interest rates over time (e.g. £1 become £1.10 in one year's time at a rate of 10%).

The cash flows earned from a project should repay the capital sum invested, but they should also be sufficient to provide a reward to investors which equals the interest cost of capital.

A second major limitation is that, in concentrating on the speed of recovery of cash flows, the method ignores any cash flows arising after the payback date. A project which would make a long-term contribution to the overall cash flows of the business could be sacrificed for short-term benefits in a project with a limited time horizon.

Activity 24.2

Check that you understand fully the calculation of the payback period and its interpretation. Write a 200-word note on the meaning and usefulness of the payback period as a means of evaluating the suitability of a project.

24.3 Accounting rate of return

24.3.1 Method of calculation

The **accounting rate of return** differs from the payback method in using accounting profits rather than cash flows. As you will by now have realised, the calculation of profits includes depreciation, which is an accounting allocation but has no cash flow effect. The attraction of using profit in a method of capital investment appraisal is that it links long-term decision making to profit as the conventional measure of success in business.

Definition

The **accounting rate of return** is calculated by taking the average annual profits expected from a project as a percentage of the capital invested.

Average annual profit is calculated as average annual cash flow minus annual depreciation.

Some books recommend as denominator the initial amount of capital invested while others suggest the use of the average capital invested. Calculation of the average involves making some arbitrary assumptions about the way capital is used up over the

project. A simple pattern is to assume it is used up evenly. Suppose a project requires £1,000 invested at the start, there will be nothing left at the end and the capital is used up equally each year. Then the average investment is £500 (which is the average of £1,000 at the start and £nil at the end). This book will use the initial investment for illustrative purposes, but you should be aware that different definitions will be used in practice and it is important to know how any return on capital has been defined.

The data in Exhibit 24.2 may be used to illustrate the accounting rate of return as a method of **capital investment appraisal**. A straight-line method of depreciation is applied, assuming a zero residual value, so that depreciation of £40,000 per annum (calculated as £120,000/3) is deducted from cash flows. The resulting profits and accounting rate of return are shown in Exhibit 24.4.

Exhibit 24.4 shows that Project C has the highest rate of return, Project A is next in rank and Project B has the lowest rate of return. The accounting rate of return gives a ranking of the three projects different from that given by the payback method. Project B remains the least attractive but the positions of Projects A and C are reversed. That is because C creates more cash flow in total but the cash flows of A arise earlier than those of C.

Exhibit 24.4
Calculations for the accounting rate of return

Cash flows	*Project A*	*Project B*	*Project C*
	£	£	£
Outlay (a)	120,000	120,000	120,000
Profits, after deducting depreciation from cash flows			
Year 1	20,000	5,000	nil
Year 2	20,000	5,000	30,000
Year 3	20,000	5,000	40,000
Average annual profit (b)	20,000	5,000	23,000
Accounting rate of return (b × 100/a)	16.7%	4.2%	19.2%

24.3.2 Usefulness and limitations of accounting rate of return

The accounting rate of return is regarded as a useful measure of the likely success of a project because it is based on the familiar accounting measure of profit. It is also regarded as useful because it takes into the calculation all the profits expected over the project life (in contrast to the payback method which ignores all cash flows beyond the payback date).

A major defect of the accounting rate of return is that it ignores the **time value of money**. It makes no distinction between two projects of the same average profit, one of which gives most of its profits at an early stage and the other of which gives most of its profits at a later stage.

A less serious defect, but nevertheless a limitation, is that the accounting rate of return depends on profit which, in turn, includes a subjective accounting estimate of depreciation. That may not matter too much in an example of the type illustrated in Exhibit 24.4, where average profits are used and straight-line depreciation is applied

across all projects, but there could be situations where different depreciation policies could distort a decision based on the accounting rate of return.

Activity 24.3

Before proceeding further, make sure that you understand fully the calculation and usefulness of the accounting rate of return. Write a 200-word note on the limitations of relying on the accounting rate of return when evaluating a project.

24.4 Net present value method

The **net present value** (NPV) method of **capital investment appraisal** is a technique which seeks to remedy some of the defects of **payback** and the **accounting rate of return**. In particular it takes into account all cash flows over the life of the project and makes allowance for the time value of money. Before the net present value method can be explained further, it is necessary to make a short digression into the **time value of money**.

24.4.1 Time value of money

If £100 is invested at 10% per annum, then it will grow to £110 by the end of the year. If the £100 is spent on an item of business machinery, then the interest is lost. So the act of investing leads to a lost opportunity of earning investment. The idea of applying calculations of the time value of money is a way of recognising the reward needed from a project to compensate for the lost opportunity.

Suppose now that you have been given a written promise of £100 to be received in one year's time. Interest rates are 10%. You do not want to wait one year to receive cash and would like the money now. What is the price for which you could sell that promise? Most students see the answer as £90.91 intuitively, but they do not all see immediately how they arrived at that answer. (It might be useful for you to think out your own approach before you read the next few paragraphs. It is much easier to work something out for yourself than to try remembering formulae which you will forget in a crisis.)

The intuitive answer is that £90.91 is the amount which, invested now at 10%, would grow to £100 in one year's time. Provided the promise is a good one, there would be no problem in selling the £100 promise for £90.91 now. Both the buyer and the seller would be equally satisfied that the price reflected the time value of money.

Now make it a little harder. Suppose the promise of £100 was for payment in *two* years' time. What is the price for which you could sell that promise now? The answer is £82.64 because that would grow at 10% to £90.91 at the end of one year and to £100 at the end of two years.

The calculation of the value of the promise today can be conveniently represented in mathematical notation as follows:

Definition

The **present value** of a sum of £1 receivable at the end of n years when the rate of interest is r% per annum equals:

$$\frac{1}{(1+r)^n}$$

where r represents the annual rate of interest, expressed in decimal form, and n represents the time period when the cash flow will be received.

The process of calculating present value is called **discounting.** The interest rate used is called the **discount rate**.

Using this calculation to illustrate the two calculations already carried out intuitively, the present value of a sum of £100, due one year hence, when the discount rate (interest rate) is 10%, is calculated as:

$$\frac{£100}{(1 + 0.1)^1} = £90.91$$

The **present value** of a sum of £100, due two years' hence, when the interest rate is 10%, is calculated as:

$$\frac{£100}{(1 + 0.1)^2} = £82.64$$

The calculation using this formula is no problem if a financial calculator or a spreadsheet package is available, but can be tedious if resources are limited to a basic pocket calculator. In such circumstances, some people prefer to use tables of discount factors which give the present value of £1 for every possible rate of interest and every possible time period ahead. A full table of discount factors is set out in the supplement at the end of this chapter.

In this supplement, the column for the discount rate of 10% has the following discount factors:

At end of period	*Present value of £1*
1	0.909
2	0.826
3	0.751

Using the tables, for the discount rate of 10%, it may be calculated that the present value of £100 receivable at the end of Year 1 is £100 × 0.909 = £90.90, while the present value of £100 receivable at the end of Year 2 is £100 × 0.826 = £82.60. (There is a difference in the second place of decimals when this answer is compared with the result of using the formula. The difference is due to rounding in the discount tables.)

Now that you are familiar with the calculation of the present value of a promised future cash flow, the explanation of the net present value method of capital investment appraisal may be given.

Activity 24.4

Use your calculator to check the discount factors for the present value of £1 at the end of one year, two years and three years for a discount rate of 10%. Write a parallel table for 8% and 12%. Show that the discount factor decreases as the discount rate increases.

24.4.2 The net present value decision rule

The **net present value** (NPV) method of **capital investment appraisal** is based on the view that a project will be regarded as successful if the present value of all expected cash inflows is greater than, or equal to, the capital invested at the outset. It is called *net* present value because, in calculation, the capital invested is deducted from the present value of the future cash flows. (Use of the word 'net' always means that one item is being deducted from another.) If the present value of the expected cash flows is greater than the capital invested, then the net present value will be positive. If the present value of the expected cash flows is less than the capital invested, then the net present value will be negative. A positive net present value indicates that the project should be accepted, while a negative net present value indicates that it should be rejected.

Definition

The **net present value** of a project is equal to the present value of the cash inflows minus the present value of the cash outflows, all discounted at the cost of capital.

Cash flows are calculated as profit before deducting depreciation and amortisation.

The NPV decision rule is as follows:

1. Where the net present value of the project is *positive*, accept the project.
2. Where the net present value of the project is *negative*, reject the project.
3. Where the net present value of the project is zero, the project is acceptable in meeting the cost of capital but gives no surplus to its owners.

If an organisation seeks to maximise the wealth of its owners, then it should accept any project which has a positive net present value. If finance markets are working efficiently, funds will always be available to finance projects which meet or exceed their cost of capital.

24.4.3 The cost of capital

The rate of interest used in the calculation of net present value is called the **discount rate**. It is based on the cost to the business of raising new finance. This is called the **cost of capital**. If the project is to be financed only by borrowing from banks then the cost of capital is the rate of interest that a bank would charge for a new loan. If the project is to be financed only by issuing new share capital then the cost of capital is the dividend yield required by investors. If the project is to be financed by cash that has been saved within the business, then the shareholders have allowed this saving rather than take dividend, so the cost of capital is the opportunity cost reflected in the dividend yield.

When the business finances projects by a mixture of sources of finance, the cost of capital is a mixture of the related costs. It is calculated by a weighted average of the interest rate on loans and the dividend yield on share capital. The weights used are based on the relative amounts of loan finance and equity finance used by the company. If you study corporate finance you will learn more about estimating the weighted average cost of capital. For any exercise in this book you will be informed of the discount rate to be used.

24.4.4 Residual value

At the end of a project's life there may be cash flows that can be collected from sale of equipment or recovery of cash invested in inventories and debtors. Any cash flows from residual value should be included in the projected cash flows and discounted from the end of the project.

24.4.5 Illustration

The illustration in Exhibit 24.5 sets out the data for Project A taken from Exhibit 24.2. Exhibit 24.6 sets out the net present value calculation, assuming a discount rate of 10%. Based on the **net present value** rule Project A will be accepted as it gives a positive net present value.

Exhibit 24.5
Data for net present value illustration

Cash flows	*Project A* £
Outlay	120,000
Cash inflows, after deducting all outflows of the year:	
Year 1	60,000
Year 2	60,000
Year 3	60,000

Exhibit 24.6
Calculation of net present value: Project A

Using the formula approach the net present value is calculated as:

$$\frac{£60{,}000}{(1.10)} + \frac{£60{,}000}{(1.10)^2} + \frac{£60{,}000}{(1.10)^3} - £120{,}000$$

$$= £54{,}550 + £49{,}590 + £45{,}080 - £120{,}000 = £29{,}220$$

Using the discount tables the net present value is calculated as:

End of year	*Cash flow* £	*Discount factor*	*Present value* £
1	60,000	0.909	54,540
2	60,000	0.826	49,560
3	60,000	0.751	45,060
Present value of cash flows			149,160
Less initial outlay			(120,000)
Net present value			29,160

Rounding errors

The answer obtained from the discount tables (£29,160) differs marginally from that obtained from the formula (£29,220), because the discount factors are rounded to three decimal places. In many cases, such differences are marginal to the overall calculation and you should not worry about them. If, in any particular case, the rounding errors are likely to have an impact, then the formula should be used rather than the tables of discount factors. In real life it is questionable whether any decision should be based on fine-tuning of rounding errors. The conclusion should be clear from the overall magnitudes being calculated and should not be dependent on differences of very small magnitude.

Activity 24.5

If you have access to a spreadsheet package, find out whether it has a net present value (NPV) function. If so, use the data in Exhibit 24.5 to satisfy yourself that the spreadsheet produces answers similar to those derived here.

Cash flow patterns assumed by the net present value calculation

It is worth pausing to analyse the cash flow patterns which are assumed by the net present value calculation. This analysis helps in understanding when it is safe to use the net present value approach to capital investment appraisal and when it should be applied with caution.

Assume the investor who has provided the capital of £120,000 requires 10% interest at the end of each year, to be paid out of the cash flows. Assume that any surplus cash flows are retained in the business and reinvested at 10%. The accumulation of cash generated by the project is shown in Exhibit 24.7. The cash balance at the end of Year 3 is £159,000, out of which the original capital of £120,000 is repaid, leaving an actual surplus of £39,000. That surplus arising at the end of Year 3 has a present value of £29,000 (£39,000 × 0.751) which is the answer derived earlier by the net present value calculation (allowing for rounding differences).

Exhibit 24.7
Accumulation of cash during a project

Year	*Balance of cash at start of year (1) £000s*		*Interest earned on balance invested (2) £000s*		Cash flow *(3) £000s*		*Interest paid (4) £000s*		*Balance of cash at end of year (1 + 2 + 3 – 4) £000s*
1	nil	+	–	+	60	–	12	=	48
2	48	+	5	+	60	–	12	=	101
3	101	+	10	+	60	–	12	=	159

Exhibit 24.7 is provided here to illustrate one of the assumptions of the net present value calculation which requires some thought. It assumes that surplus cash generated during the project can be invested at the cost of capital. Whether or not that is the case for a particular project is more an issue for study in the area of finance, but in real life it is rare that the interest earned on deposited funds is as high as that paid on borrowings. What is possible in many situations is that the surplus cash is used to start further projects in the business and those new projects are also successful in creating positive net present values of cash flows at the organisation's cost of capital.

Projects B and C

Now consider Projects B and C. The net present value of each project is calculated in Exhibits 24.8 and 24.9.

Project C has the highest net present value, followed by Project A. Both would be acceptable because both have a positive net present value. Project B would be rejected because it gives a negative net present value.

Exhibit 24.8
Calculation of net present value: Project B

Using the discount tables the net present value is calculated as follows:

End of year	*Cash flow* £	*Discount factor*	*Present value* £
1	45,000	0.909	40,905
2	45,000	0.826	37,170
3	45,000	0.751	33,795
			111,870
Less initial outlay			(120,000)
Net present value			(8,130)

Exhibit 24.9
Calculation of net present value: Project C

Using the discount tables the net present value is calculated as follows:

End of year	*Cash flow* £	*Discount factor*	*Present value* £
1	40,000	0.909	36,360
2	70,000	0.826	57,820
3	80,000	0.751	60,080
			154,260
Less initial outlay			(120,000)
Net present value			34,260

In real life, obtaining finance may be difficult because of temporary imbalance in the capital markets or because the supply of capital within the organisation is constrained. If the organisation is in the public sector it may be subject to a cash limit of capital expenditure. If it is in the private sector and is a subsidiary or a division within a group, it may be restricted by the group's plans for total fund-raising by the group. Such practical problems are sometimes referred to as *capital rationing* and will lead to organisations devising decision rules for ranking projects. These ranking decisions will not be explored in detail here but it is important to note that any project which is rejected, when it has a positive net present value, will be a loss to the potential wealth of the owners of the business.

24.5 Internal rate of return

Net present value is only one method in capital investment appraisal which takes into account the time value of money. The decision rule is based on the absolute amount of the net present value of the surplus generated by the project. There is some evidence from research into the practical use of capital investment appraisal techniques that decision makers feel more comfortable with a percentage rather than an absolute amount. (The reason is not so clear but could be linked to the historical reliance on the accounting rate of return as a percentage.)

The **internal rate of return** (IRR) is another method in capital investment appraisal which uses the time value of money but results in an answer expressed in percentage form. It is a discount rate which leads to a net present value of zero, where the present value of the cash inflows exactly equals the cash outflows.

Definition

The **internal rate of return** (IRR) is the discount rate at which the present value of the cash flows generated by the project is equal to the present value of the capital invested, so that the net present value of the project is zero.

24.5.1 Method of calculation

The calculation of the internal rate of return involves a process of repeated guessing at the **discount rate** until the present value of the cash flows generated is equal to the capital investment. That guessing may be carried out by computer, asking the computer to try values of the discount factor in the formula. Most spreadsheet computer packages have the facility to perform a calculation of internal rate of return once the initial investment and cash flows have been entered on the spreadsheet.

$$\text{Initial investment} = \frac{C_1}{(1+d)} + \frac{C_2}{(1+d)^2} + \frac{C_3}{(1+d)^3} + \cdots + \frac{C_n}{(1+d)^n}$$

That process of repeated guessing is extremely time-consuming if a computer is not used. Even where a computer is used, it needs to be provided with a first guess which is reasonably close. For a manual process of estimation it may be easier to use discount tables, with an aim of arriving at a reasonably close answer, rather than worrying too much about figures beyond the decimal point.

Take, as an illustration, the data on Project A of Exhibit 24.2, repeated in Exhibit 24.5. The starting point for calculating IRR is to find two values of NPV using discount rates lying either side of the IRR. Exhibit 24.10 sets out two such calculations. A first guess of 20% produces a net present value which is positive. The aim is to find the discount rate which gives a zero net present value, so the first guess must have been too low and a higher discount rate of 24% is used for the second guess.

Exhibit 24.10
Calculation of net present value at 20% and at 24%

	Cash flows £	*Discount rate 20%*	£	*Discount rate 24%*	£
End of Year 1	60,000	0.833	49,980	0.806	48,360
End of Year 2	60,000	0.694	41,640	0.650	39,000
End of Year 3	60,000	0.579	34,740	0.524	31,440
			126,360		118,800
Outlay			(120,000)		(120,000)
Net present value			6,360		(1,200)

The second guess was a fortunate one because the net present value changed from being positive at 20% to being negative at 24%. That means that the net present value of zero must be found at a discount rate between these two rates. If the second guess had failed to give a negative net present value, a further guess would have been required.

The actual discount rate which gives a zero net present value may now be found by assuming a linear interval between 20% and 24%. (The interval is not exactly linear but may be taken as approximately so over a narrow difference in rates.)

The difference between the two net present values is £6,360 – (–£1,200), that is £7,560. The difference between the two discount rates is 4% and therefore, using simple proportion calculations, the net present value of zero lies at:

$$20\% + \left(\frac{6{,}360}{7{,}560} \times 4\right) = 23.365\%$$

Exhibit 24.11 sets out the linear relationship which is assumed in the calculation. The process of estimation shown there is called *interpolation*. In words, the formula used in this calculation is:

$$\text{Lower of the pair of discount rates} + \left(\frac{\text{NPV at lower rate}}{\text{Difference between the NPVs}} \times \text{Difference in rates}\right)$$

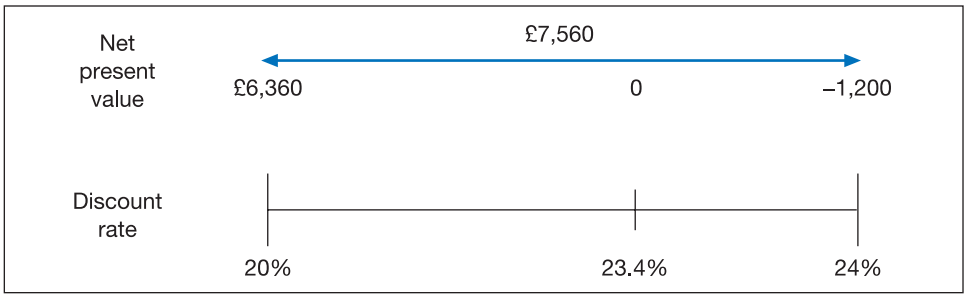
The internal rate of return answer, as produced by a computer package, is 23.375%. The use of a simple proportion calculation appears to provide a good approximation.

Activity 24.6

If you have access to a computer spreadsheet package which has an internal rate of return function, test the data used in the chapter. It will ask you for a first guess and will then proceed to repeat the calculation of IRR until it arrives at a net present value of zero.

Exhibit 24.11

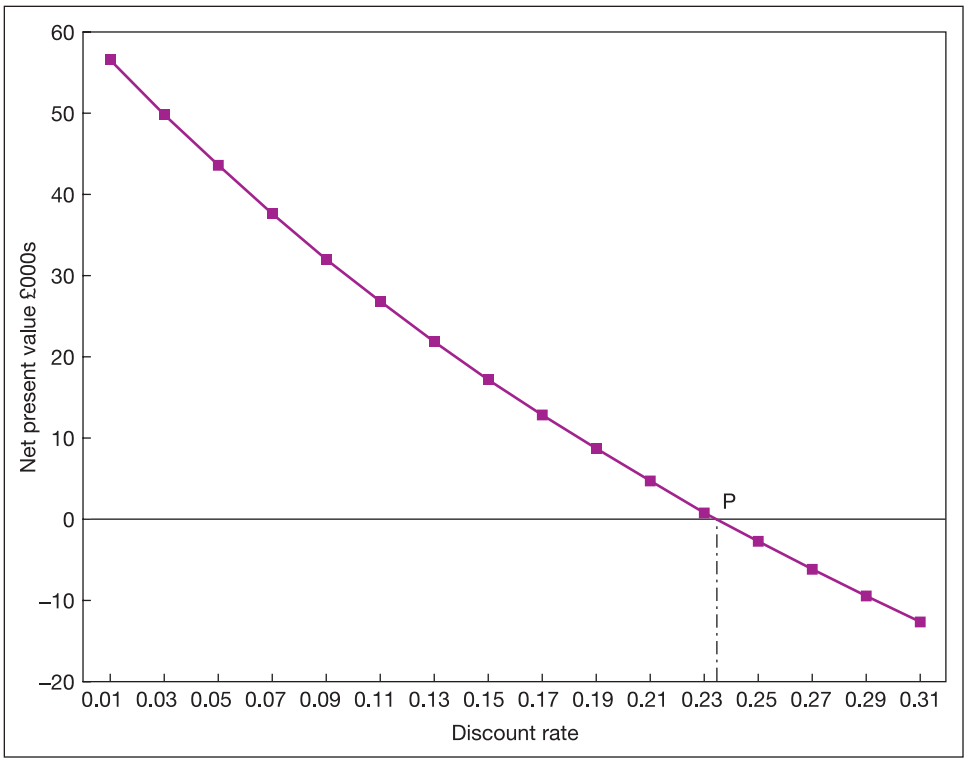
Locating the internal rate of return between two discount rates of known net present value



It is also possible to plot a graph of net present value against discount rate, as shown in Exhibit 24.12. The internal rate of return is the discount rate at which the graph crosses the horizontal line representing zero net present value. That point is designated with a letter P in the graph and is shown to be around 23.4% by a vertical dotted line from P to the horizontal axis.

Exhibit 24.12

Graph of net present value against discount rate showing internal rate of return



24.5.2 The internal rate of return decision rule

The decision rule is that a project is acceptable where the **internal rate of return** is greater than the cost of capital. Under those conditions the net present value of the project will be positive. A project is not acceptable where the internal rate of return is less than the cost of capital. Under those conditions the net present value of the project will be negative.

1. Where the IRR of the project is greater than the cost of capital, accept the project.
2. Where the IRR of the project is less than the cost of capital, reject the project.
3. Where the IRR of the project equals the cost of capital, the project is acceptable in meeting the required rate of return of those investing in the business but gives no surplus to its owners.

When the net present value and the internal rate of return criteria are applied to an isolated project, they will lead to the same accept/reject decision because they both use the discounting method of calculation applied to the same cash flows. For an isolated project the use of either technique is a matter of personal preference. Where a choice of competing projects has to be made, the practice may be more complicated. The techniques available for dealing with that problem are beyond the scope of this book, but the next section outlines the nature of the problem.

24.6 Mutually exclusive projects

An organisation may need to make a choice between two projects which are **mutually exclusive** (perhaps because there is only sufficient demand in the market for the output of one of the projects, or because there is a limited physical capacity which will not allow both). Some care is then required in using the net present value and the internal rate of return as decision criteria. In many cases they give the same answer on relative ranking, but occasionally they may give different answers, as shown in the following case example.

24.6.1 Case study: whisky distillery

A distillery is planning to invest in a new still. There are two plans, one of which involves continuing to produce the traditional mix of output blends and the second of which involves experimentation with new blends. The second plan will produce lower cash flows in the earlier years of the life of the still, but it is planned that these cash flows will overtake the traditional pattern within a short space of time. Only one plan may be implemented. The project is to be appraised on the basis of cash flows over three years. The cash flows expected are shown in Exhibit 24.13. The cost of capital is 12% per annum. At this discount rate the net present values are shown in the second table of Exhibit 24.13. The internal rates of return are also shown in that table.

Exhibit 24.13
Cash flows, NPV and IRR for two mutually exclusive projects

Project	*Initial investment*	*Cash flows*		
		Year 1	*Year 2*	*Year 3*
	£	£	£	£
A	120,000	96,000	48,000	12,000
B	120,000	12,000	60,000	108,000

Project	*NPV at 12%*	*IRR*
	£	
A	12,521	20.2%
B	15,419	17.6%

It may be seen from Exhibit 24.13 that, looking at the net present value at the cost of capital, project B appears the more attractive with the higher net present value. Looking at the internal rate of return, project A appears most attractive. Both are acceptable because they give a positive net present value and the ideal answer would be to find the resources to undertake both projects. In this example, the two are mutually exclusive (which means that taking on one project excludes the possibility of the other).

If the business has the aim of maximising net present value, then one further decision rule may be helpful, based on the **profitability index**.

Definition

The **profitability index** is the present value of cash flows (discounted at the cost of capital) divided by the present value of the investment intended to produce those cash flows.

The project with the highest profitability index will give the highest net present value for the amount of investment funding available. Taking the data in Exhibit 24.13, the profitability index calculations are:

$$\text{Project A: Profitability index} = \frac{132{,}521}{120{,}000} = 1.10$$

$$\text{Project B: Profitability index} = \frac{135{,}419}{120{,}000} = 1.13$$

This confirms that, of the two, project B is preferable at a cost of capital of 12%. Where the investment in both projects is of the same amount, as in this case, the profitability index confirms what is already obvious, but where there are competing projects of differing initial investment, it is a useful device for ranking projects to maximise net present value.

24.6.2 Sensitivity to changes in the discount rate

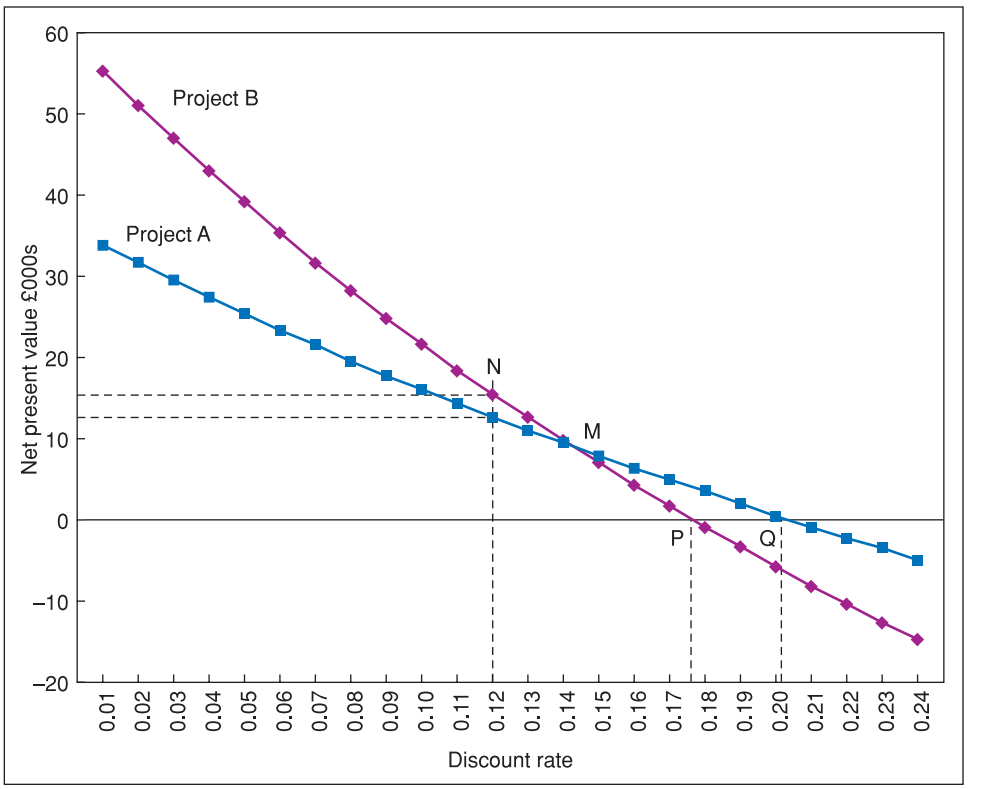
To understand the apparently different conclusions from the NPV and IRR approaches, it is helpful to plot a graph of the net present value of each project against a range of discount rates. The graph is shown in Exhibit 24.14.

From Exhibit 24.14, it will be seen that, for both projects, the net present value decreases as the discount rate increases but that the net present value of project B decreases more rapidly. Starting at the left-hand side of the graph, the net present value of project B is higher than that of project A at all discount rates above the point, M, at which they intersect (around 14.2%). In particular project B has a higher net present value than project A at the cost of capital 12% (point N on the graph). For discount rates above 14.2%, the net present value of project B is always higher than that of project A. The internal rate of return of each project is the discount rate at which they cross the line of zero net present value (i.e. at point P for project B and point Q for project A).

How does this help the decision maker? If it is absolutely certain that the cost of capital will remain at 12% throughout the life of the project, then the net present value method correctly leads to a choice of project B in preference to project A. On the other hand, 12% is quite close to the point of intersection at 14.2%, where project A takes over. If there is a chance that the cost of capital will in reality be higher than the 12% expected, then it might be safer to choose project A. The line of the graph for project A is less steep and this project is said to be less sensitive to changes in the discount rate. There is therefore no clear-cut answer to the problem and the final decision will be based on an assessment of sensitivity. Looking at Exhibit 24.14, the different ranking by net present value and by internal rate of return was a useful clue to the need to consider the relative sensitivities as shown in the graph.

Exhibit 24.14

Net present value of competing projects using a range of discount rates



24.7 Which methods are used in practice?

This chapter has now explained the capital investment appraisal techniques of payback, accounting rate of return, net present value and internal rate of return. The benefits and limitations of each have been discussed in the respective sections. It could be argued that the proof of the value of each technique lies in the extent to which it is used in practice. There exists a considerable volume of survey research seeking an answer to the question of which methods are most commonly used in practice. The conclusions from each project are not totally unanimous because they depend on the time period covered by the research, the nature of the sample chosen, the country in which the questions are asked and the questions asked. There are themes which may be discerned in the research results, the first of which is that the payback method appears to be the most frequently used technique in the UK but discounted cash flow methods are found more commonly in the USA. It is also found that organisations will use more than one method of capital investment appraisal. Where discounting methods are used, internal rate of return appears more popular than net present value.

Research investigations are able to collect information of this type. Once the patterns are known, it is interesting to speculate on the motives behind these patterns of choice. Perhaps the payback method is most frequently used because there are many small businesses undertaking lots of small projects. It might not matter that discounting methods are used less frequently provided they are used on the larger projects in larger organisations. This issue has also been tested in research and it has been shown that larger companies do make relatively more use of discounting techniques. Perhaps the payback method, in many cases, shows so clearly that a project is acceptable that it

would be a waste of time to carry out lengthy discounting calculations to arrive at the same conclusion. Perhaps those using payback realise that, in some instances, its emphasis on early cash flows is not so different from that of the net present value approach in situations where the later cash flows are relatively low.

24.8 Control of investment projects: authorisation and review

The capital investment projects of an organisation represent major commitments of resources. It would be a mistake to be overenthusiastic about decision-making techniques without considering also how management accounting may help in the subsequent implementation of the project.

The organisation should have in place a procedure by which new project suggestions are investigated and evaluated using the techniques described in this chapter, or suitable alternatives. There should then be a decision-making group, perhaps called the capital investment appraisal committee or the management review committee, which makes decisions on the projects to be selected. Once the decision has been made and the capital investment appraisal committee has authorised the project to proceed, the management accountant is again needed in implementing a system for reviewing and controlling the project.

The two important aspects of control and review are:

1 controlling the amount of the expenditure needed to make the project operational;
2 post-completion audit of cash inflows and outflows.

24.8.1 Controlling capital expenditure

The specification of the project will have included an estimate of the initial outlay required and the timing of that outlay. For simplification, the illustrations used in this chapter assumed a single amount being paid out at the start of the project, but in real life the capital expenditure will be spread over a period of time on an agreed schedule. If the capital expenditure involves constructing a building, there will be a contract for the building work which sets out the dates for completion of each stage and the amount of cash to be paid at that point. The payment will only be made when an expert (such as the architect supervising the project) has confirmed that the work has been carried out according to the specification. If a contract has been drawn up with care, it will contain safeguards to ensure that the work is completed on time and within the original cost estimates. There may be a penalty clause, so that a part of the cash payment may be withheld if the contract is not performed as promised.

Activity 24.7

Write a list of key points to be made in a recommendation to the board of directors on the implementation of an expenditure control process for capital investment plans.

24.8.2 Post-completion audit

A **post-completion audit** involves a review of the actual results of a project in order to compare these with the expectations contained in the project proposals. It is called an audit because it requires a more flexible approach than would be found in management accounting evaluations of short-term plans (as covered in Chapter 20). The post-completion audit might require a view of the wider implications of the project rather than concentrating too much on annual cash flows item by item. A project might take a different turn from that envisaged at the outset and a longer-term view

would be required of the likely outcome of that different turn. In real life, uncertainty is a factor which cannot easily be built into the project plans and the audit may have to take account of factors which could not have been foreseen at the outset.

There could be dangers in such an audit process if managers of projects see themselves as being held to blame for a subsequent failure to meet expectations. They might be motivated to put forward only those projects which they saw as safe but unadventurous. The review process has to be flexible to allow for the unknown but also to discourage unrealistic or overenthusiastic plans.

24.9 Advanced manufacturing technologies

Advanced technologies in manufacturing (AMTs) have been developed by engineers as a means of competing more effectively. To compete, organisations need to manufacture innovative products of high quality at low cost. The product life-cycle may be short, demand may be changing more rapidly, and international competition creates a further element of uncertainty. As with any business activity, these changes represent new approaches to the management of the business, and management accounting must keep pace with the change in management approach.

24.9.1 Types of new technology

Engineers have produced new technology of four main types:

1 design innovations;
2 planning and control techniques;
3 execution; and
4 overarching technologies.

Each of these new technologies is considered in turn.

The *design innovations* have covered computer-aided design (CAD), computer-aided engineering (CAE), computer-aided process planning (CAPP) and design for manufacture and assembly. CAD uses computers to evaluate various designs of the product, while CAE includes design but also encompasses evaluation and testing so that the initial design becomes a working product. CAPP uses computers to plan the detailed processes required to manufacture the design proposed. Finally, the computer can also be used to design a system which makes the manufacture and assembly process meet the demand for the output.

Planning and control techniques have covered materials requirements planning (MRP), manufacturing resource planning (MRP II) and statistical process control (SPC). MRP involves matching stock levels to the production process and controlling incoming customer orders to match the availability of materials. MRP II applies similar controls to all resources used in the manufacturing process. They both use computers to break down a customer's order into various stages which can be matched against resource availability. SPC uses statistical analysis to identify the most likely causes of bottlenecks in the manufacturing process, which can then be corrected before a crisis arises.

Execution means converting raw materials and components into finished goods. The technologies have included robotics, automated guided vehicles (AGVs), flexible manufacturing systems (FMS) and automated storage and retrieval systems (ASRS). These titles are self-descriptive of the activities involved.

The *overarching technologies* are those which take a total perspective of the organisation. They include total quality management (TQM), just-in-time (JIT), focused factory and computer-integrated manufacturing (CIM). TQM and JIT are described in Chapter 25.

24.9.2 Capital investment appraisal of AMT projects

The conventional methods of investment appraisal have been presented as payback, accounting rate of return, net present value and internal rate of return. These techniques have considerable benefit for many situations where a fixed investment is made and the outcome may be projected forward. However, they are not capable of taking into account the flexibility which management may have in some situations. As flexible technology takes over from fixed inflexible capital equipment, there are options facing the business manager which must be considered in project evaluation.

In particular there are options to make modifications to projects or add on new aspects. Abandonment may be less difficult where technology is flexible. Companies may feel that they can afford to wait and learn before investing. A project can be scaled down if there are changes in demand for a product. These options make project development quite exciting but they also offer a challenge to the management accountant in making sure the options are evaluated.

Fiona McTaggart describes an example of capital investment in an AMT situation:

FIONA: *One case I encountered was that of a flexible manufacturing system being used to machine metal into engineering components. There was hardly a person in sight on the production line. Computer controlled machines were each performing one part of the treatment of the metal. Cutting tools were making metal shapes, transport systems were moving components around and then, depending on where the shapes were delivered, there were more machines to turn, mill, polish and shape. The whole process was controlled by a host computer and was sufficiently flexible that if the transport system was revised then the activities performed on the metal changed as well.*

The company adapted its investment appraisal methods by involving the engineers and the management accountants as a team. Essentially they evaluated reduced labour costs, increased effectiveness in utilisation of machines, cost saving through just-in-time control of materials and the reduction in indirect costs. Discounted cash flows were included in order to take account of the longer term but the emphasis was more strongly on the short term and the flexibility for change if conditions changed.

The debate on the role of capital investment appraisal techniques in relation to advanced manufacturing technologies is a useful example of the wider point that management accounting must continually be changing to adapt to changed circumstances. A book can present basic ideas, but those ideas will only work effectively in a practical situation if moulded to meet the needs of the situation.

24.10 Summary

Key themes in this chapter are:

- **Capital investment appraisal** is the application of a set of methods of quantitative analysis which give guidance to managers in making decisions as to how best to invest long-term funds. Four methods of quantitative analysis are explained in the chapter:
- The **payback period** is the length of time required for a stream of net cash inflows from a project to equal the original cash outlay.
- The **accounting rate of return** is calculated by taking the average annual profits expected from a project as a percentage of the capital invested.

- The process of calculating present value is called **discounting**. The interest rate used is called the **discount rate**. The net present value method of investment appraisal and the internal rate of return method are both based on discounting.
- The **net present value** of a project is equal to the present value of the cash inflows minus the present value of the cash outflows, all discounted at the cost of capital. The decision rules are:
  1 Where the net present value of the project is *positive*, accept the project.
  2 Where the net present value of the project is *negative*, reject the project.
  3 Where the net present value of the project is zero, the project is acceptable in meeting the cost of capital but gives no surplus to its owners.
- The **internal rate of return** (IRR) is the discount rate at which the present value of the cash flows generated by the project is equal to the present value of the capital invested, so that the net present value of the project is zero. The decision rules are:
  1 Where the IRR of the project is greater than the cost of capital, accept the project.
  2 Where the IRR of the project is less than the cost of capital, reject the project.
  3 Where the IRR of the project equals the cost of capital, the project is acceptable in meeting the required rate of return of those investing in the business but gives no surplus to its owners.
- **Mutually exclusive projects** are found wherever a choice is needed because of limited resources of capital, labour, materials, or any other constraint.
- The **profitability index** may be used to rank projects in situations of capital rationing or mutually exclusive projects.
- Effective **capital investment appraisal** requires control procedures to be in place for establishing the suitability of a project and for post-completion audit to evaluate the success of the project.
- **Advanced manufacturing technologies** have led to a demand for new ways of evaluating investment projects because new projects may require continuous investment of resources rather than a single outlay at the outset.

Further reading

Brounen, D., de Jong, A. and Koedijk, K. (2004) 'Corporate Finance in Europe: Confronting Theory with Practice', *Financial Management*, Tampa USA, 33(4): 71–101.

QUESTIONS

The Questions section of each chapter has three types of question. 'Test your understanding' questions to help you review your reading are in the 'A' series of questions. You will find the answers to these by reading and thinking about the material in the book. 'Application' questions to test your ability to apply technical skills are in the 'B' series of questions. Questions requiring you to show skills in problem solving and evaluation are in the 'C' series of questions. A letter [S] indicates that there is a solution at the end of the book.

A Test your understanding

A24.1 What is the purpose of capital investment appraisal? (Section 24.1.1)

A24.2 What is meant by the assumption of certainty of cash flows? (Section 24.1.2)

A24.3 What are the main steps in making a decision about a capital investment? (Section 24.1.3)

A24.4 What is the payback method of evaluating a project? (Section 24.2)

A24.5 What are the advantages and limitations of the payback method? (Section 24.2.3)

A24.6 What is the accounting rate of return? (Section 24.3)

A24.7 What are the advantages and limitations of the accounting rate of return as a technique for use in capital investment appraisal? (Section 24.3.2)

A24.8 What is meant by the time value of money? (Section 24.4.1)

A24.9 What is meant by the present value of a cash flow? (Section 24.4.1)

A24.10 What is meant by the term 'discounting'? (Section 24.4.1)

A24.11 Define net present value and explain how it is calculated. (Section 24.4.2)

A24.12 State the net present value decision rule to be used in capital investment appraisal. (Section 24.4.2)

A24.13 Define internal rate of return and explain how it is calculated. (Section 24.5.1)

A24.14 State the internal rate of return decision rule to be used in capital investment appraisal. (Section 24.5.2)

A24.15 Explain the problems which may arise in choosing between mutually exclusive projects. (Section 24.6)

A24.16 Explain the processes necessary for authorisation and review of capital projects. (Section 24.8)

A24.17 Explain what is meant by Advanced Manufacturing Technologies. (Section 24.9)

A24.18 Explain why present value techniques may not be suitable for project evaluation where a business uses Advanced Manufacturing Technologies. (Section 24.9.2)

A24.19 **[S]** Calculate the present value of £100 receivable at the end of (a) one year, (b) two years and (c) three years, using a discount rate of 8% per annum.

A24.20 **[S]** Calculate the present value of £100 receivable at the end of five years using a discount rate of (a) 4%, (b) 6% and (c) 8% per annum.

B Application

B24.1 **[S]**

Projects Ltd intends to acquire a new machine costing £50,000 which is expected to have a life of five years, with a scrap value of £10,000 at the end of that time.

Cash flows arising from operation of the machine are expected to arise on the last day of each year as follows:

End of year	£
1	10,000
2	15,000
3	20,000
4	25,000
5	25,000

Calculate the payback period, the accounting rate of return and the net present value, explaining the meaning of each answer you produce. (Assume a discount rate of 10% per annum.)

B24.2 [S]
In a calculation of the internal rate of return of a project it is found that the net present value is +£122m at 22% discount rate and –£58m at 24% discount rate. What is the internal rate of return?

B24.3 [S]
XYZ Ltd is considering purchasing a new machine, and the relevant facts concerning two possible choices are as follows:

	Machine A	*Machine B*
Capital expenditure required	£65,000	£60,000
Estimated life in years	4	4
Residual value	nil	nil
Cash flow after taxation each year	£25,000	£24,000

The company's cost of capital is 10%.

Required
Calculate, for each machine, the payback period, the net present value and the profitability index. State, with reasons, which machine you would recommend.

B24.4 [S]
Marsh Limited has investigated the possibility of investing in a new machine. The following data have been extracted from the report relating to the project:

- Cost of machine on 1 January Year 6: £500,000.
- Estimated scrap value at end of Year 5: Nil.

Year	*Net cash flows £000*
1	50
2	200
3	225
4	225
5	100

The company's cost of capital is 8%.

Required
Evaluate the acceptability of the project using the net present value method of investment appraisal.

B24.5
In a calculation of the internal rate of return of a project it is found that the net present value is +£60m at 24% discount rate and –£20m at 26% discount rate. What is the Internal Rate of Return?

C Problem solving and evaluation

C24.1 [S]
Offshore Services Ltd is an oil-related company providing specialist firefighting and rescue services to oil rigs. The board of directors is considering a number of investment projects to improve the cash flow situation in the face of strong competition from international companies in the same field.

The proposed projects are:

Project	*Description*
ALPHA	Commission an additional firefighting vessel.
BRAVO	Replace two existing standby boats.
CHARLIE	Establish a new survival training course for the staff of client companies.
DELTA	Install latest communications equipment on all vessels.

Each project is expected to produce a reduction in cash outflows over the next five years. The outlays and cash benefits are set out below:

	End of year	*ALPHA £000s*	*BRAVO £000s*	*CHARLIE £000s*	*DELTA £000s*
Outlay	–	(600)	(300)	(120)	(210)
Cash flow benefits:					
	1	435	–	48	81
	2	435	–	48	81
	3	–	219	48	81
	4	–	219	48	81
	5	–	219	48	81
Internal rate of return		28.8%	22.0%	28.6%	26.8%

Any project may be postponed indefinitely. Investment capital is limited to £1,000,000. The board wishes to maximise net present value of projects undertaken and requires a return of 10% per annum.

Required

Prepare a report to the board of directors containing:

1 calculations of net present value for each project, and

2 a reasoned recommendation on maximisation of net present value within the £1,000,000 investment limit.

C24.2 [S]

The directors of Advanced plc are currently considering an investment in new production machinery to replace existing machinery. The new machinery would produce goods more efficiently, leading to increased sales volume. The investment required will be £1,150,000 payable at the start of the project. The alternative course of action would be to continue using the existing machinery for a further five years, at the end of which time it would have to be replaced.

The following forecasts of sales and production volumes have been made:

Sales (in units)

Year	*Using existing machinery*	*Using new machinery*
1	400,000	560,000
2	450,000	630,000
3	500,000	700,000
4	600,000	840,000
5	750,000	1,050,000

Production (in units)

Year	*Using existing machinery*	*Using new machinery*
1	420,000	564,000
2	435,000	637,000
3	505,000	695,000
4	610,000	840,000
5	730,000	1,044,000

Further information

(a) The new machinery will reduce production costs from their present level of £7.50 per unit to £6.20 per unit. These production costs exclude depreciation.
(b) The increased sales volume will be achieved by reducing unit selling prices from their present level of £10.00 per unit to £8.50 per unit.
(c) The new machinery will have a scrap value of £150,000 after five years.
(d) The existing machinery will have a scrap value of £30,000 at the start of Year 1. Its scrap value will be £20,000 at the end of Year 5.
(e) The cost of capital to the company, in money terms, is presently 12% per annum.

Required

1 Prepare a report to the directors of Advanced plc on the proposed investment decision.
2 List any further matters which the directors should consider before making their decision.

C24.3

The board of directors of Kirkside Glassware Ltd is considering the following proposed investment projects:

Project	*Nature*
A	Establishment of a staff training scheme.
B	Major improvements to the electrical system.
C	Installation of a computer.
D	Development of a new product.
E	Purchase of a warehouse space, presently leased.

It is estimated that each product will provide benefits in terms of reduced cash outflows, measured over the coming five years. The outlays and cash flow benefits, net of taxation, are set out below:

	End of year	*Project A* £	*Project B* £	*Project C* £	*Project D* £	*Project E* £
Outlay	–	(40,000)	(70,000)	(180,000)	(100,000)	(200,000)
Cash flow benefits:						
	1	16,000	27,000	66,000	–	145,000
	2	16,000	27,000	66,000	–	145,000
	3	16,000	27,000	66,000	73,000	–
	4	16,000	27,000	66,000	73,000	–
	5	16,000	27,000	66,000	73,000	–
Internal rate of return		28.65%	26.82%	24.32%	22.05%	28.79%

Each project has two separate phases of equal cost and providing equal cash flow benefits. The board is willing to consider adopting the first phase of any project without the second, if this appears necessary. Any project or phase not undertaken immediately may be postponed indefinitely. Capital available for investment is limited to £300,000. The board aims, as far as possible, to maximise the net present value of projects undertaken.

The company requires a return of 10% per annum based on the net cash flows of any project.

Required

Prepare a report to the board of directors:

1 setting out a decision rule which could be applied in ranking the investment projects, and
2 listing other factors which the board of directors might wish to consider when selecting projects for implementation.

Cases for study groups

Case 24.1

Using a suitable computer spreadsheet package, set up a spreadsheet which will calculate net present values and internal rates of return for projects having cash flows for a ten-year period. Test the spreadsheet with sample data and then write a brief instruction sheet. Save the spreadsheet to a disk and exchange disks and instruction sheets with another group in the class.

Case 24.2

Now write an evaluation of the spreadsheet you have received from another group. Consider the following:

(a) Does it deal with all possible types of cash flows (e.g. a negative flow at some point)?
(b) Does it provide a recommendation on accept/reject (e.g. using a conditional function)?
(c) Does it allow for relatively easy variation of the discount rate?
(d) Does the instruction sheet explain how to produce graphs of net present value plotted against discount rate?

List any other features of the spreadsheet which you would use in evaluating its effectiveness and user-friendliness.

Table of discount factors

Number of years	*1%*	*2%*	*3%*	*4%*	*5%*	*6%*	*7%*	*8%*	*9%*	*10%*	*11%*	*12%*	*13%*	*14%*	*15%*
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885	0.877	0.870
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	0.812	0.797	0.783	0.769	0.756
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	0.731	0.712	0.693	0.675	0.658
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	0.659	0.636	0.613	0.592	0.572
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	0.593	0.567	0.543	0.519	0.497
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	0.535	0.507	0.480	0.456	0.432
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	0.482	0.452	0.425	0.400	0.376
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	0.434	0.404	0.376	0.351	0.327
9	0.914	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	0.391	0.361	0.333	0.308	0.284
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	0.352	0.322	0.295	0.270	0.247
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.350	0.317	0.287	0.261	0.237	0.215
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	0.286	0.257	0.231	0.208	0.187
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	0.258	0.229	0.204	0.182	0.163
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	0.232	0.205	0.181	0.160	0.141
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	0.209	0.183	0.160	0.140	0.123
16	0.853	0.728	0.623	0.534	0.458	0.394	0.339	0.292	0.252	0.218	0.188	0.163	0.141	0.123	0.107
17	0.844	0.714	0.605	0.513	0.436	0.371	0.317	0.270	0.231	0.198	0.170	0.146	0.125	0.108	0.093
18	0.836	0.700	0.587	0.494	0.416	0.350	0.296	0.250	0.212	0.180	0.153	0.130	0.111	0.095	0.081
19	0.828	0.686	0.570	0.475	0.396	0.331	0.277	0.232	0.194	0.164	0.138	0.116	0.098	0.083	0.070
20	0.820	0.673	0.554	0.456	0.377	0.312	0.258	0.215	0.178	0.149	0.124	0.104	0.087	0.073	0.061
21	0.811	0.660	0.538	0.439	0.359	0.294	0.242	0.199	0.164	0.135	0.112	0.093	0.077	0.064	0.053
22	0.803	0.647	0.522	0.422	0.342	0.278	0.226	0.184	0.150	0.123	0.101	0.083	0.068	0.056	0.046
23	0.795	0.634	0.507	0.406	0.326	0.262	0.211	0.170	0.138	0.112	0.091	0.074	0.060	0.049	0.040
24	0.788	0.622	0.492	0.390	0.310	0.247	0.197	0.158	0.126	0.102	0.082	0.066	0.053	0.043	0.035
25	0.780	0.610	0.478	0.375	0.295	0.233	0.184	0.146	0.116	0.092	0.074	0.059	0.047	0.038	0.030
26	0.772	0.598	0.464	0.361	0.281	0.220	0.172	0.135	0.106	0.084	0.066	0.053	0.042	0.033	0.026
27	0.764	0.586	0.450	0.347	0.268	0.207	0.161	0.125	0.098	0.076	0.060	0.047	0.037	0.029	0.023
28	0.757	0.574	0.437	0.333	0.255	0.196	0.150	0.116	0.090	0.069	0.054	0.042	0.033	0.026	0.020
29	0.749	0.563	0.424	0.321	0.243	0.185	0.141	0.107	0.082	0.063	0.048	0.037	0.029	0.022	0.017
30	0.742	0.552	0.412	0.308	0.231	0.174	0.131	0.099	0.075	0.057	0.044	0.033	0.026	0.020	0.015

Note: Present value of £1 to be received after n years when the rate of interest is r% per annum equals $1/(1 + r)^n$.

Number of years	*16%*	*17%*	*18%*	*19%*	*20%*	*21%*	*22%*	*23%*	*24%*	*25%*	*26%*	*27%*	*28%*	*29%*	*30%*
1	0.862	0.855	0.847	0.840	0.833	0.826	0.820	0.813	0.806	0.800	0.794	0.787	0.781	0.775	0.769
2	0.743	0.731	0.718	0.706	0.694	0.683	0.672	0.661	0.650	0.640	0.630	0.620	0.610	0.601	0.592
3	0.641	0.624	0.609	0.593	0.579	0.564	0.551	0.537	0.524	0.512	0.500	0.488	0.477	0.466	0.455
4	0.552	0.534	0.516	0.499	0.482	0.467	0.451	0.437	0.423	0.410	0.397	0.384	0.373	0.361	0.350
5	0.476	0.456	0.437	0.419	0.402	0.386	0.370	0.355	0.341	0.328	0.315	0.303	0.291	0.280	0.269
6	0.410	0.390	0.370	0.352	0.335	0.319	0.303	0.289	0.275	0.262	0.250	0.238	0.227	0.217	0.207
7	0.354	0.333	0.314	0.296	0.279	0.263	0.249	0.235	0.222	0.210	0.198	0.188	0.178	0.168	0.159
8	0.305	0.285	0.266	0.249	0.233	0.218	0.204	0.191	0.179	0.168	0.157	0.148	0.139	0.130	0.123
9	0.263	0.243	0.225	0.209	0.194	0.180	0.167	0.155	0.144	0.134	0.125	0.116	0.108	0.101	0.094
10	0.227	0.208	0.191	0.176	0.162	0.149	0.137	0.126	0.116	0.107	0.099	0.092	0.085	0.078	0.073
11	0.195	0.178	0.162	0.148	0.135	0.123	0.112	0.103	0.094	0.086	0.079	0.072	0.066	0.061	0.056
12	0.168	0.152	0.137	0.124	0.112	0.102	0.092	0.083	0.076	0.069	0.062	0.057	0.052	0.047	0.043
13	0.145	0.130	0.116	0.104	0.093	0.084	0.075	0.068	0.061	0.055	0.050	0.045	0.040	0.037	0.033
14	0.125	0.111	0.099	0.088	0.078	0.069	0.062	0.055	0.049	0.044	0.039	0.035	0.032	0.028	0.025
15	0.108	0.095	0.084	0.074	0.065	0.057	0.051	0.045	0.040	0.035	0.031	0.028	0.025	0.022	0.020
16	0.093	0.081	0.071	0.062	0.054	0.047	0.042	0.036	0.032	0.028	0.025	0.022	0.019	0.017	0.015
17	0.080	0.069	0.060	0.052	0.045	0.039	0.034	0.030	0.026	0.023	0.020	0.017	0.015	0.013	0.012
18	0.069	0.059	0.051	0.044	0.038	0.032	0.028	0.024	0.021	0.018	0.016	0.014	0.012	0.010	0.009
19	0.060	0.051	0.043	0.037	0.031	0.027	0.023	0.020	0.017	0.014	0.012	0.011	0.009	0.008	0.007
20	0.051	0.043	0.037	0.031	0.026	0.022	0.019	0.016	0.014	0.012	0.010	0.008	0.007	0.006	0.005
21	0.044	0.037	0.031	0.026	0.022	0.018	0.015	0.013	0.011	0.009	0.008	0.007	0.006	0.005	0.004
22	0.038	0.032	0.026	0.022	0.018	0.015	0.013	0.011	0.009	0.007	0.006	0.005	0.004	0.004	0.003
23	0.033	0.027	0.022	0.018	0.015	0.012	0.010	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002
24	0.028	0.023	0.019	0.015	0.013	0.010	0.008	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002
25	0.024	0.020	0.016	0.013	0.010	0.009	0.007	0.006	0.005	0.004	0.003	0.003	0.002	0.002	0.001
26	0.021	0.017	0.014	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.002	0.002	0.002	0.001	0.001
27	0.018	0.014	0.011	0.009	0.007	0.006	0.005	0.004	0.003	0.002	0.002	0.002	0.001	0.001	0.001
28	0.016	0.012	0.010	0.008	0.006	0.005	0.004	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001
29	0.014	0.010	0.008	0.006	0.005	0.004	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.000
30	0.012	0.009	0.007	0.005	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.000	0.000