you read this book. There are three other important points that need to be mentioned here.

- Systems analysis and design involves people. Certainly it involves technology, often technology that we don't really understand and which we rely on other people to manage for us, but the best-designed systems in the world succeed because the people who use them can do their jobs better. This is because their information systems enable them to achieve goals they wouldn't otherwise reach. There are just too many people on trains and planes using laptop machines to believe that we can ever in the future manage without computers. The importance of this 'people aspect' is emphasised later where we consider change management.
- Systems analysts and designers change the world. This is a bold statement, and in one sense everyone changes the world to some extent just by their very existence. The role of the systems analyst, however we may describe it in detail, is to be a change agent. Unless we are interested in changing the way organisations work we have no need for systems analysts. Unless you are interested in changing the way organisations work, you probably have no need to read this book.
- Information systems are expensive to develop and maintain, so it is clear that businesses do not commission them just for the fun of it. The need for an information system must grow out of some perceived business requirement, and the justification for it must be expressed in business terms. Although this is well enough understood in theory, it is surprising how often IS projects do start without clear links back to business plans and strategies. System developers often take the sketchiest of briefs and start to develop something they think meets the need – and are then unpleasantly surprised when the user or sponsor of the system refuses to accept it because it does not properly meet their specific business requirements.

1.2 Business Analysis

1.2.1 Levels of Understanding

A proper analysis of system requirements requires that those carrying out the investigation have a balance of skills and knowledge. This includes a good general understanding of the operation of business and of the factors that affect the viability of all businesses. This involves a broad-based knowledge of finance, accounting, marketing, production and distribution, ideally gained in a variety of business environments. There will also be a need for a more specific grasp of the important features of the particular business being studied. So, for example, an analyst working for a high street chain of shops should have knowledge of the retail sector and be able to discuss retailing matters knowledgeably with the customer. Finally of course a broad knowledge of the possibilities and limitations of information technology is also required.

This balance of skills is needed for three reasons. First, so that the analysts understand what the users of the proposed system are saying to them and can recognise the implications of the requirements they are capturing. Also, because users will not expect analysts to adopt a completely passive role; they will want them to challenge assumptions and interject ideas to stimulate them in thinking out their requirements. Without an understanding of the business of the organisation, or of how other organisations have tackled similar issues, it will not be possible to play this catalytic role. Finally, the users will generally expect the analysts to devise and propose technical solutions to their business problems.

Systems analysts, however, are often generalists and, particularly in service companies, are quite likely to be sent to work with a travel agent on one project, a bank on the next and a manufacturing company on the third. Although this can facilitate cross-fertilisation of ideas between different sorts of business, the disadvantage is, of course, that they sometimes lack the specialist knowledge to deal with users on an equal basis. So if this is the case, what can be done to bring relevant experience to bear on a particular assignment?

First, and most obviously, the project manager should try to find analysts with previous experience of the business to be studied, or something similar. Someone who has worked on a distribution application, for instance, may have achieved a reasonable understanding of areas such as stock-keeping and just-in-time delivery systems, which can be brought into play on a retail assignment. If, however, analysts with relevant backgrounds are not available, additional support will have to be provided by arranging some training for the analysts in the areas of interest in the form of public courses or self-teach packages, or by hiring an expert to coach them in the new business areas. Alternatively, suitable background reading can be provided. Another approach is to provide consultancy support, which can be used either to lead the investigation with the customer or to provide background advice and guidance for the analysis team.

A particular challenge for analysts, and one that seems more difficult for those from a technical background such as programming, is to keep the business requirements as the focus instead of getting hooked up on technological solutions. It is very easy, for example, to take a messy and cumbersome manual system and produce instead a messy and cumbersome computer system. Analysis should at all times be tightly focused on the business objectives that the proposed system is supposed to fulfil, and only when these are thoroughly clear should the identification of technical solutions be attempted. As we shall see in Chapter 2, structured methods, particularly SSADM, provide a very good discipline in this regard, as they tend to conduct requirements analysis and requirements specification at a wholly logical level and deliberately exclude the consideration of technical issues until the business requirements have been settled.

1.2.2 Linkage of IS to Business Objectives

There are many reasons why businesses should want to develop information systems, but some of the most common objectives are:

- *To reduce manpower costs*. The introduction of computer-based systems has often enabled work to be done by fewer staff or, more likely nowadays, has permitted new tasks to be undertaken without increasing staffing levels. The automation of many banking functions, such as cheque clearance, falls into this category.
- *To improve customer service*. Computer systems can often allow organisations to serve customers more quickly or to provide them with additional services. Supermarket point-of-sale systems producing itemised bills provide an illustration of this.
- *To improve management information*. Management decisions can only be as good as the information on which they are based, so many computer systems have been designed to produce more, or more accurate, or more timely information. With modern database query facilities it is even possible to provide systems that do not require the data retrieval requirements to be defined in advance, thereby enabling managers to institute new types of enquiry when changing business conditions demand new or different information.
- *To secure or defend competitive advantage*. This is becoming a major justification for spending on information systems, and is examined in more detail later in this chapter.

Ideally, the analyst should work from a hierarchy of objectives, each one posing a challenge to, and imposing constraints upon, those at a lower level. The lower-level objectives are sometimes referred to as *critical success factors*: that is, they are things that must be achieved if the top-level objective is to be met. The critical success factors will become more detailed and tightly focused as one works down the hierarchy, and perhaps this may be best illustrated by an example.

Let us consider a motor-car manufacturing company. It currently has, say, 10% of the market for its products, and the board has defined a five-year mission of raising that proportion to 20%. But this is a very broad target and, to achieve it, the organisation will have to define a set of more tangible objectives that will lead to its being met – in other words, the critical success factors. It may be felt that one key to increasing market share is to offer a more frequent choice of new models. So, a lower-level objective for the design team may be to reduce the time to develop a new model from, say, five years to two. And the production department will have to be able to switch over assembly lines in less time, say a reduction from six months to three.

Coming down a stage further still, the designers will want to introduce technology that can produce manufacturing instructions, documentation to support the issuing of tenders to subcontractors, component listings and setup instructions for the assembly lines from their drawings. Now, we can derive some very focused critical success factors for our information system based upon these detailed requirements. It can be seen, then, that business objectives and critical success factors 'cascade' from one level to another, and the whole set should form a pyramid supporting the overall aims of the business.

1.3 Constraints

The range of potential solutions that may be proposed by the analyst will be limited by constraints imposed by the user and by the nature of the user's business. The analyst should ideally undertand these constraints before analysis begins but certainly as it progresses, and must keep them firmly in mind as the ideas for the proposed system emerge.

1.3.1 The User's Organisation

The first thing for the analyst to consider is the structure of the user's organisation. It may, for example, operate in a very centralised fashion with nearly all decisions being made at head office. If this is the case, then clearly information systems must reflect this pattern and be designed so that relevant information can be processed rapidly and presented at the heart of the business. If, on the other hand, the organisation allows considerable autonomy to managers in subsidiary parts of the business, then the systems must be designed to provide these managers with what they need to run the business effectively. In other words the systems must reflect the structure of decision-making in the business.

It is important to remember, however, that organisations are not static and tend to oscillate between centralisation and devolution as circumstances, the business and intellectual climate and the most recent theories of management gurus dictate. Nowadays, the difficulty of altering information systems can prove a major obstacle to reorganisation. Some might think this to be a good thing, but it is important not to make systems so inflexible that they actually prevent the organisation from being operated in the way the management decides is necessary.

1.3.2 Working Practices

It is easiest to introduce a new information system if it leaves existing working practices largely undisturbed. Conversely, systems that require a lot of change may prove very difficult to implement.

However, the analyst must not allow a fear of the difficulty of implementation to prevent the best solution – best for the business as a whole, that is – being advocated. The most radical changes will often provide the greatest gains, and if that is so then the problems of implementation must be faced and overcome, and the chapter on change management gives some ideas that help in this difficult process. Alternatively, the management of the organisation may want to use the introduction of new technology as a catalyst for change, to shake up a sleepy, backward-looking department for instance.

The key point is that the analyst must make some assessment of the climate prevailing in the organisation. Will its management wholeheartedly push for change, give it lukewarm support, or just run away from its implications? Finally, at a more prosaic level, some working practices that may appear overelaborate and cumbersome will turn out to have evolved for good business reasons – such as the maintenance of safety standards on a railway for example.

The analyst must make very sure that these business reasons are not ignored in proposing new and more streamlined systems.

1.3.3 Financial Control Procedures

Various aspects of the way an organisation manages its finances can have an impact on IT developments. The first is the concept of capital versus revenue expenditure. Most IT developments involve capital expenditure in that they are funded as one-off projects rather than out of continuing expenses. But the payoff for a capital project may be a reduced continuing revenue cost somewhere downstream. Depending on the organisation's rules for the 'payback' on capital projects, a capital project cost of, say, £3 million may not be justifiable even if, over a seven-year system life, it could produce revenue savings of 'only' £1 million per annum.

Also, organisations may have only limited funds earmarked for capital projects in a given year but have reasonably generous revenue budgets for ongoing work. In these circumstances it may be sensible to propose a limited initial capital expenditure for a core system, with enhancements and additions being made gradually as funds permit.

The analyst needs to consider who actually holds the purse strings for a particular development and what it is that will convince that person of the worth of the proposed development. Let us suppose, by way of example, that we are to examine the requirements for a new payroll system in an organisation. The paymaster could be the payroll manager, who wants a fully comprehensive system that will enable him or her to offer new services and perhaps even take over the functions of the corporate personnel system, or it could be the IT director, who is developing a strategy of packaged systems running on 'open' architectures, or the finance director, who wants a system that will cut the number of staff, and hence the costs, in the payroll department. The objectives of each of these managers are rather different, and if the analyst is to get a solution adopted, it must be geared to the needs of the person, or people, who will approve and pay for it.

1.3.4 Security and Privacy

The analyst needs to determine fairly early on which sort of security conditions will be required for the proposed information system. These could include:

- ordinary commercial confidentiality, where the main aim is to ensure that sensitive commercial information such as, for instance, the production cost breakdown of products cannot be stolen by the competition;
- more sensitive systems, such as the Police National Computer, where special considerations apply to the holding of, and access to, data;
- very secure systems, such as those that support the armed services and government agencies.

Clearly, the need for rigorous security control could impose major constraints and development costs on the project.

1.3.5 Legal Considerations

It is becoming increasingly the case that the users of information systems are liable for the consequences of things done, or put in train, by those systems. If there are such liabilities, the analyst must examine them and allow for them in the proposed system. Safety-critical systems are the most obvious example, and if one were examining the requirements for, say, an air traffic control system, safety considerations would constitute one of the main constraints of the proposed solution. Other systems have also fallen foul of the law recently, and it cannot be too long before, for example, a credit-scoring agency is found to be liable for the consequences of wrongly deciding that someone is a bad risk.

So far, too, there has been little legal exploration of the subject of consequential losses arising from the use of information systems, and developers have been able to hide behind contract clauses that limit their liability to the cost of the systems's development or some arbitrary figure. There must be some possibility that this will change in the future, so the analyst, in assessing the risks from some proposed solution, ought at least to think about what might be the consequential losses resulting in a system failure.

The law does already have something to say on the subject of storing information about individuals, in the form of data protection legislation. This has two aspects that particularly concern us. These are ensuring that the data is held only for defined and declared purposes, and enabling those with a statutory right to inspect information held about them to do so. So, if the proposed information system may hold information on individuals, the analyst needs to ensure that the requirements of the legislation can be met.

1.3.6 Audit Requirements

An organisation's internal and external auditors will want access to systems to ensure that they are working properly and that the financial information they produce can be relied upon. They may also require that certain self-checking mechanisms and authorisation procedures be incorporated into systems. In some types of system – those supporting pension funds or banks are obvious examples – the need to check and extract audited information forms a large part of the requirement itself. It is very much better, not to say easier, if these audit requirements can be taken into account at the specification and design stage rather than added after the system is complete, so the analyst must talk to all the relevant authorities and find out their requirements alongside those of the more obvious users of the system.

1.3.7 Fallback and Recovery

Most information systems have some sort of requirement for fallback and recovery. These requirements could include the ability to 'roll back' the system to some point before failure and then to come forward progressively to bring the information up to date, or some back-up means of capturing data while the main

system is off-line. Standby systems that normally perform less urgent tasks can take over from 'critical' systems, and, if necessary, full system duplication or even triplication may be provided for critical real-time or command-and-control systems. Provision of back-up, though necessary, is expensive, and so the case for the arrangements provided must be examined in strict business terms and the effects on the business of system failure assessed. 'What would be the costs involved?' and 'How long could the business go without the system?' are two of the more important questions to be answered. Recent terrorist attacks have demonstrated the importance of back-up systems and the speed with which they can be brought on-line after a disaster.

Sometimes the analysis of these consequences can produce truly frightening results. In one case there was an investigation of a system that supported a major undertaking and which had distributed data-capture and centralised control. It was found that, if the central processors went out of action for more than two days, the backlog of data in the distributed processors would be such that the system could never catch up, whereas the failure of one of the distributed machines would not become very serious for several weeks.

So, the analyst must carry out a comprehensive risk analysis in this area, using outside expertise in support if necessary, and must keep the resultant constraints in mind at all times.

1.4 Using IT for Competitive Advantage

In the early days of information systems, their justification seemed straightforward enough. For the most part the systems were 'number-crunchers' that could carry out routine repetitive tasks, such as the calculation of payrolls, much more quickly and cheaply than an army of clerks. The payoff was thus clearly in staff savings plus perhaps some additions in the form of better or more timely information for management.

There are few, if any, of these first-time applications available now, and many administrative systems are now into their third or fourth incarnations. Justification for the new developments has generally been that:

- The old ones are incompatible with newer technological platforms, resulting perhaps from a switch to 'open' architectures.
- They have become impossible to maintain because of the poor documentation or configuration management of many early systems.
- They need skills and resources to maintain them that are no longer available or are prohibitively expensive.

None of these however are business reasons in the sense that they support some key business objective; rather, they are technical reasons justified only in terms of the inherent nature of IT itself.

As expenditure on IT has risen, so managements have become increasingly keen to ensure that the money spent contributes in some tangible way to the

achievement of business objectives. At the same time, some more enlightened boards, and some IT directors with a wider interest than in the technology itself, have become interested in the idea of 'IT for competitive advantage'. The concept is simple enough. If IT can give your company some unique offering, or contribute to providing some unique offering, then it will give you a competitive edge over your competitors and hence contribute directly to increased sales and profits. Two examples may serve to illustrate the idea, which is discussed in more detail later in this section.

Example 1

One of the continuing headaches for retailers is the level of inventory, or stock, they keep in their stores. If it is too high, excess funds are tied up in it, profit margins are depressed by it, and it occupies floorspace that could be more usefully employed to display and sell goods. If inventory is too low, they risk 'stockouts', and customers cannot buy what is not on the shelves. In high-volume operations such as supermarkets, if customers cannot buy what they want immediately, they will go elsewhere, and that particular sale is gone for ever.

How can information systems help? A system is implemented that constantly monitors sales at the checkouts and signals a distribution centre when stocks of items fall below predetermined levels. Replacement stock is loaded onto trucks and, provided the operation has been set up correctly, arrives at the store just as the last item is sold. The stock is unloaded straight onto the display shelves and, without having excessive local storage space, the store is able to avoid customers going away empty-handed. Additionally, the cost savings can be passed on to customers as lower prices, thus attracting more business and improving the market share and profitability of the chain.

Example 2

In the late 1970s, many airlines were interested in seeing how they could tie travel agents and customers to their services and, by the same token, exclude their competitors. Several of them formed consortia with the idea of developing powerful booking systems that they could provide to travel agents. These would make it very much quicker and simpler for the agents to deal with the participating airlines than with their competitors. It is interesting to note that, in the major shake-up of the international airline business that occurred in the 1980s and 1990s, it was the airlines that invested most in this technology that moved to dominant positions in the marketplace.

In a competitive environment organisations grow and prosper through increasing their competitive – or strategic – advantage over their rivals. The best-known analysis of this competitive situation is Michael Porter's five forces model, which shows how competitive forces impact on an organisation. We can use this model to see how IS developments can help to improve the competitive position. First, though, because we are dealing with information systems, we need to understand the difference between data and information, and how information is created and valued.

Data is the raw material, the facts and observations of business life that by themselves have little value or useful purpose. Knowing the number of beefburgers sold today doesn't really help us to manage the burger shop unless we know how many were sold on the same day last week, the resources used in making them, the price at which they were sold, and so on. By contrast, information is data that has been processed in some way to make it useful, valuable and meaningful and a possible basis for taking decisions. In our burger shop we might for example have processed raw sales data to show sales by each hour of the day to help us to determine staffing levels.

So, to get information from data we are:

- Processing or transforming it using a defined process. Multiply the number of burgers sold each day by their price to get the revenue for the day.
- Putting it into a context that gives it meaning. Sales by each hour of the day show the busiest times and predict when most staff will be needed.
- Creating it for a purpose. We may be trying to decide whether to change employee shift patterns.
- Using it to help make better decisions through reducing uncertainty and so eliminate the amount of inefficient trial and error.

It's apparent then that information has value, but how is its value assessed? Intuitively managers often say 'No, don't do that. It's just not worth the effort to get that level of detail', or they ask themselves the question 'What would I do with that information if I had it?' The problem comes when they say 'What I'd really like to know is . . . Because then I could . . . and that would mean . . .', so there is a value in having the new information, and although it is difficult to quantify, it is an economic entity and it does have a value. The benefits that result from using information might be clearly visible – tangible benefits – such as cost savings. Or they might be intangible – soft benefits such as business expansion. Often information takes on value because it generates tangible or intangible benefits. Cost–benefit analysis attempts to identify the expected payoff from an information system by quantifying the cost of producing the information and the value of the information when it's produced.

However the cost benefit works out, information users will be concerned with its quality. Let's look at the characteristics of good quality information:

- *Relevant*. Is the information relevant, bearing in mind how I want to use it? When I'm presented with it, is extra processing needed before it gives me what I need?
- *Accurate*. Wrong or misleading information leads to wrong decisions being made. The information needs to be accurate enough for the purpose; small departments budget items of cost to the nearest £100, larger departments to the nearest £1000.

- *Enough*. Decisions are usually taken in an atmosphere of uncertainty. Getting more information isn't always the answer either as it may be neither timely nor relevant.
- *In time*. Information has much less value if it arrives late! It needs to arrive in sufficient time for thoughtful decisions to be made.
- *Clear*. Is the information presented in a form that makes it easy to understand and use? This sounds simple: we just ask the user how he or she would like it presented, and as long as there's one user with unchanging preferences and needs then we can deliver it. Multiple users with different needs and changing preferences – which is most likely to be the case – cause more difficulty.

A useful way of summarising and remembering the characteristics of good information is shown in Figure 1.1.

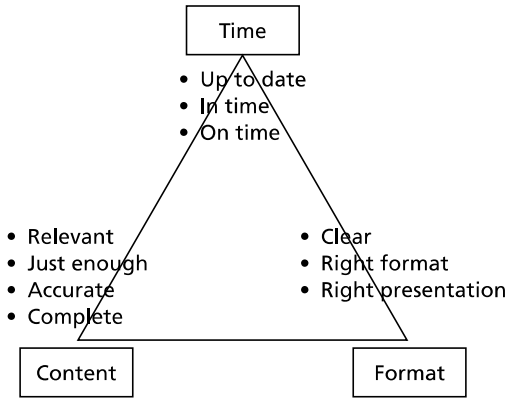

Fig. 1.1 The dimensions of good quality information

What part then does good-quality information play in giving organisations competitive advantage, whether it means more profit, greater market share, getting higher up the government league table, or meeting targets set by an industry regulator? As was said earlier, for organisations to grow and prosper they seek to gain competitive advantage, and they use information systems to develop and sustain this advantage. Here's how Porter's five forces model works. In the centre is the competitive environment, where there is *rivalry* among the existing competitors (Figure 1.2).

Fig. 1.2 The competitive environment