Chapter 10

Systems analysis

CHAPTER AT A GLANCE

Main Topics

Focus on ...

Case studies

LEARNING OBJECTIVES

After reading this chapter, readers will be able to:

- define the importance of conducting the analysis phase to the overall success of the system;
- choose appropriate techniques for analysing users' requirements for an information system;
- construct appropriate textual descriptions and diagrams to assist in summarising the requirements as an input to the design phase.

MANAGEMENT ISSUES

Careful systems analysis must be conducted on each BIS project to ensure that the system meets the needs of the business and its users. From a managerial perspective, this chapter addresses the following questions:

- Which different aspects of the system must be summarised in the requirements document?
- Which diagramming tools are appropriate to summarise the operation of the existing and proposed systems?

Activities

There are no activities for this chapter.

Case Studies

Case Study 10.1: IFD drawing – a student records system (P. 392)

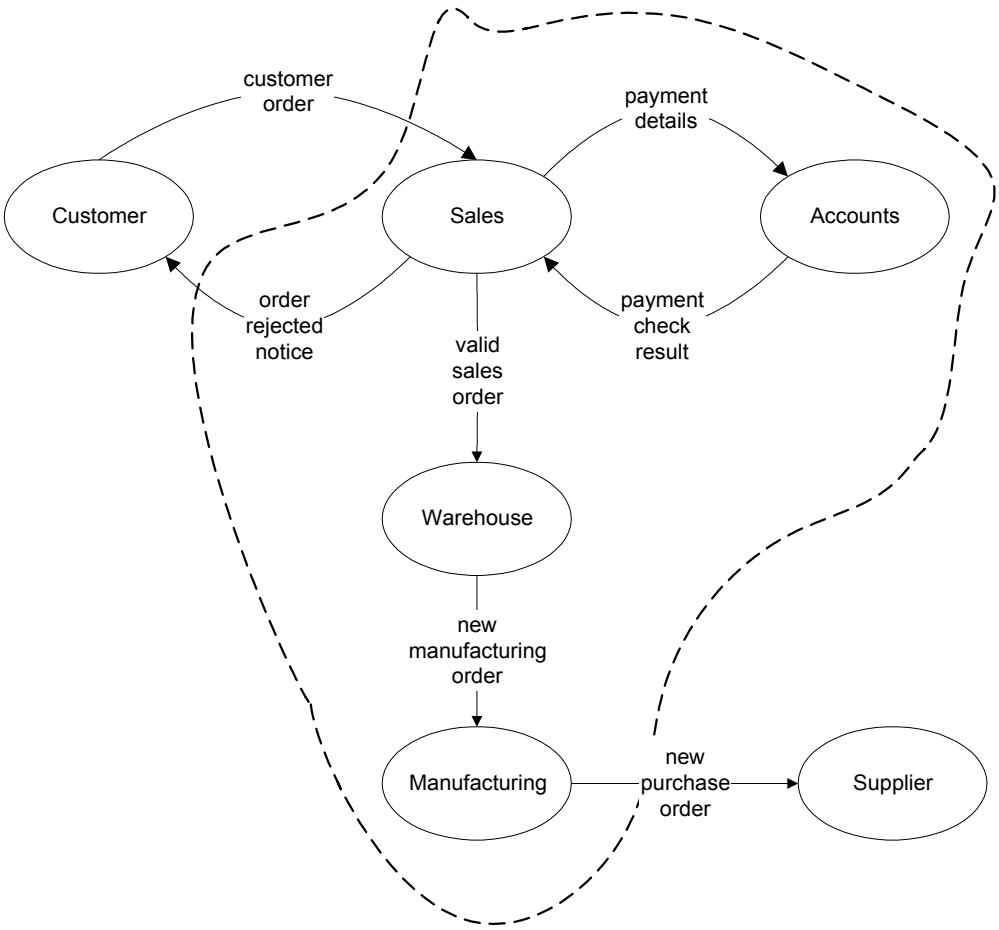
This case study does not have any questions since it takes students through the process of creating an IFD.

Case Study 10.1: ABC case study (P. 415)

1. Using the ABC case study, produce an information flow diagram for the company by following the steps given earlier in the chapter. Does the diagram tell you anything about ABC's operations which may need some attention (such as missing or superfluous information flows)?
2. Using the ABC case study and the information flow diagram that you drew in answer to Question 1, produce a simple Level 1 dataflow diagram for the company by following the steps given earlier in the chapter. Compare your answer with that by one of your colleagues. Are the diagrams the same? If not, is it possible to say which is correct? If not, why not?
3. Using the ABC case study, including the sample forms included below the main text, construct an entity relationship diagram for the company. Make sure that you do a cross-reference matrix before attempting to draw the diagram. When you have drawn your first-cut diagram, check for many-to-many relationships and eliminate any that you find by using the appropriate technique described earlier in the chapter.

1. The information flow diagram should have about six sources/destinations and about 10 information flows. It is sometimes useful to give students an idea about these numbers before they start constructing their diagrams. Students should also be encouraged to produce a list of information flows, their source and destinations before attempting to draw the diagram.

There is also a possibility that students will 'invent' information flows that they think should exist, but do not appear in the case study. Before going on to the second part of the question, students should be challenged if they have come up with these! A sample information flow diagram is shown in the figure below.

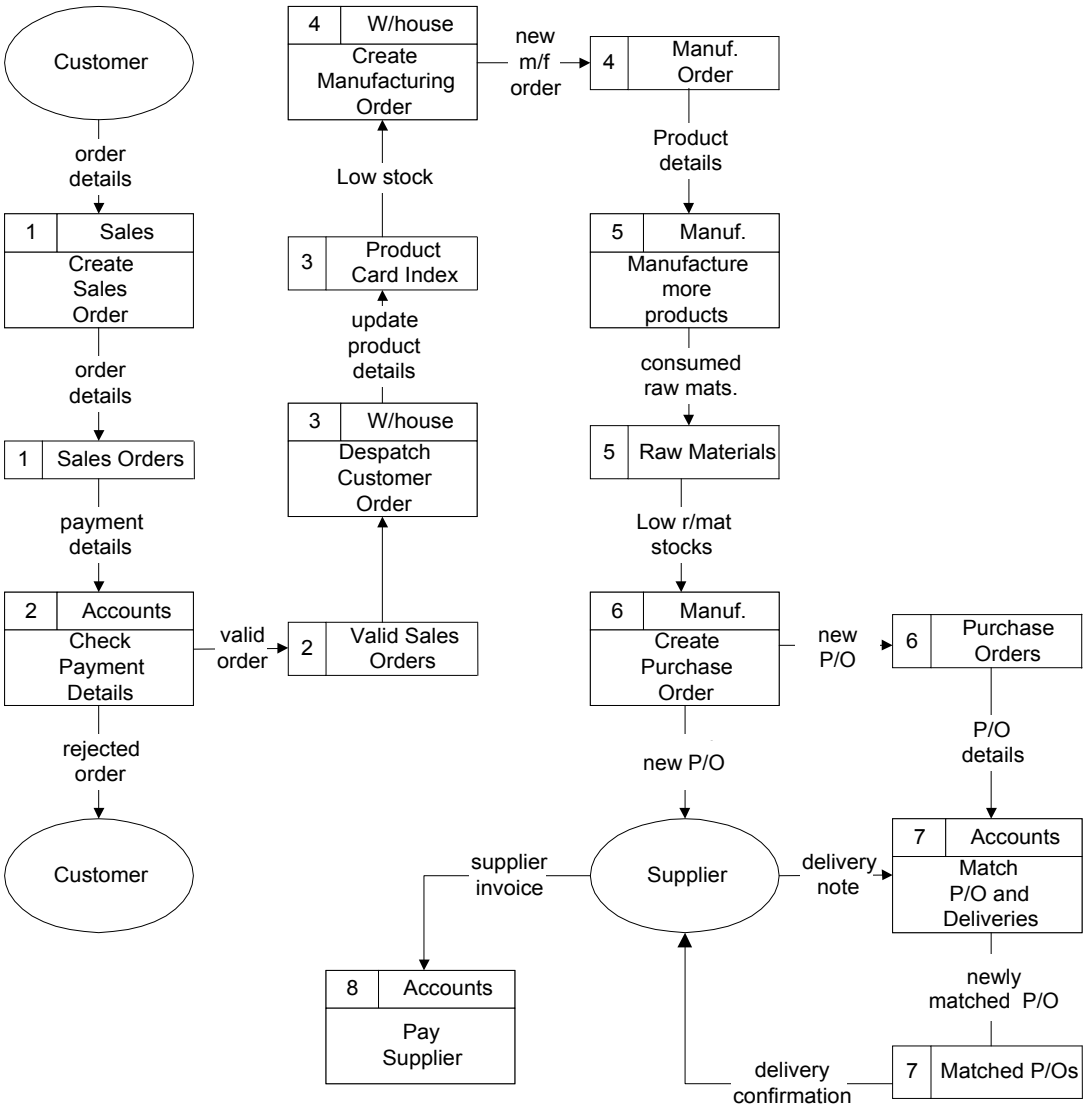


From the diagram, there is one omission that is usually identified, namely the lack of any information going back to the customer if the order is valid. This would normally take the form of a delivery note to accompany the customer's products. Students should note that goods going to the customer do not constitute an information flow but a materials flow and should not really appear on the diagram.

Another point concerns the payment to the supplier. It is a matter of some debate whether this constitutes a materials flow or an information flow. Bright students will argue that since the money transfer is actually electronic, it really is an information flow.

2. For this exercise, the students should attempt to draw their diagrams on a single sheet of A4 paper in a landscape orientation. The number of processes will vary between students (and lecturers) but should be no more that 10 to 12.

A sample diagram is given below.



It should be noted that the diagram conforms to the rules set out in Chapter 10. Especially important is the non-appearance of information flows directly between processes or datastores.
It is quite possible that students will have different interpretations of the case study. However, the processes should be essentially the same between students. What will differ very much will be the placing of the elements of the diagram on the page. Provided that the rules are followed and there are no crossed lines (except for the system boundary), differences should not be significant.

3. Students should tackle this question in four steps:

- Step one is to identify 'facts about persons, places, things or events' about which data needs to be held. When some students come up with 'ABC' or the 'Manufacturing Department' they should be challenged to say what data they would hold about these entities. They are usually removed shortly afterwards.
- Step two is to construct a cross-reference matrix showing which entities relate to each other. This is particularly difficult because at this stage students will not have a particularly good understanding of relational databases and database design (especially primary and foreign

keys). It is helpful, therefore, for students to consider the data items that each of their entities might contain and where common data between two entities exists to enable a relationship to exist (e.g. between customers and customer orders).

- Step three is to produce the first cut ERD. In the first instance, students should construct all relationships as 1:1, only adding the crow's feet at the end.
- Step four is to inspect the diagram for any many-to-many relationships and to introduce a linking entity to simplify the relationship into two one-to-many relationships. Students will not necessarily understand the importance of this at this stage. It is, therefore, important to return to this in the database design part of Chapter 12.

The sample solutions to each step are as follows.

Entities

It is suggested that the following entities should be identified:

- customers;
- sales orders;
- sales clerks;
- products;
- manufacturing orders;
- purchase orders;
- suppliers;
- supplier invoices.

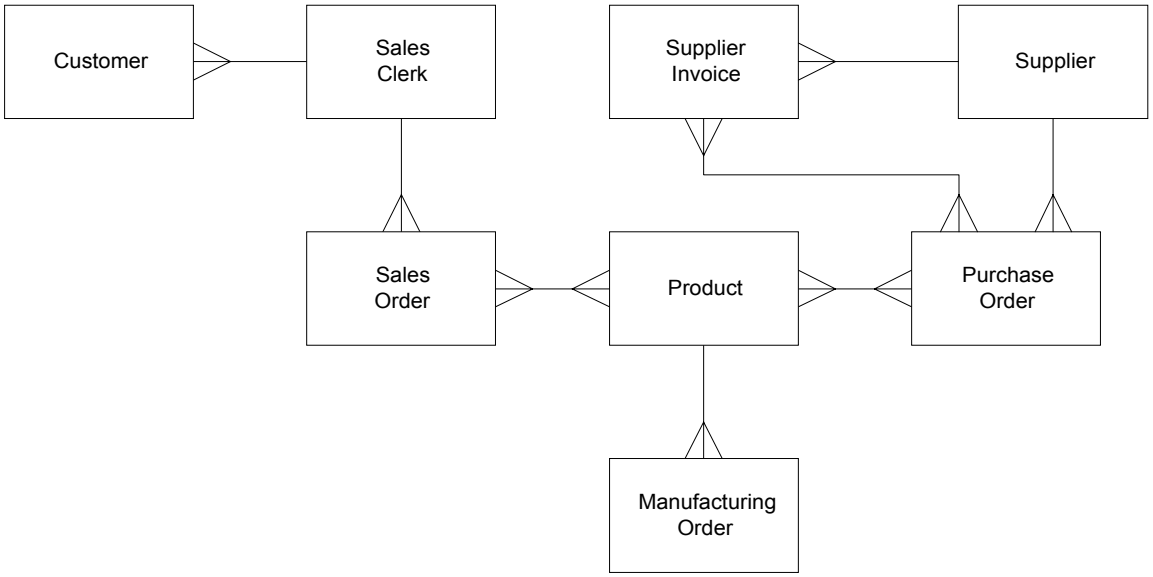
Students may come up with additional ones, some of which may be perfectly reasonable (e.g. matched P/Os as identified from the DFD).

Cross Reference matrix

	Customer	Sales Clerk	Sales Order	Product	Manufacturing Order	Purchase Order	Supplier	Invoice
Customer		☺	☺	x	x	x	x	x
Sales Clerk			☺	x	x	x	x	x
Sales Order				☺	x	x	x	x
Product					☺	☺	☺	x
Manufacturing Order						x	x	x
Purchase Order							☺	☺
Supplier								☺
Invoice								

First cut ERD

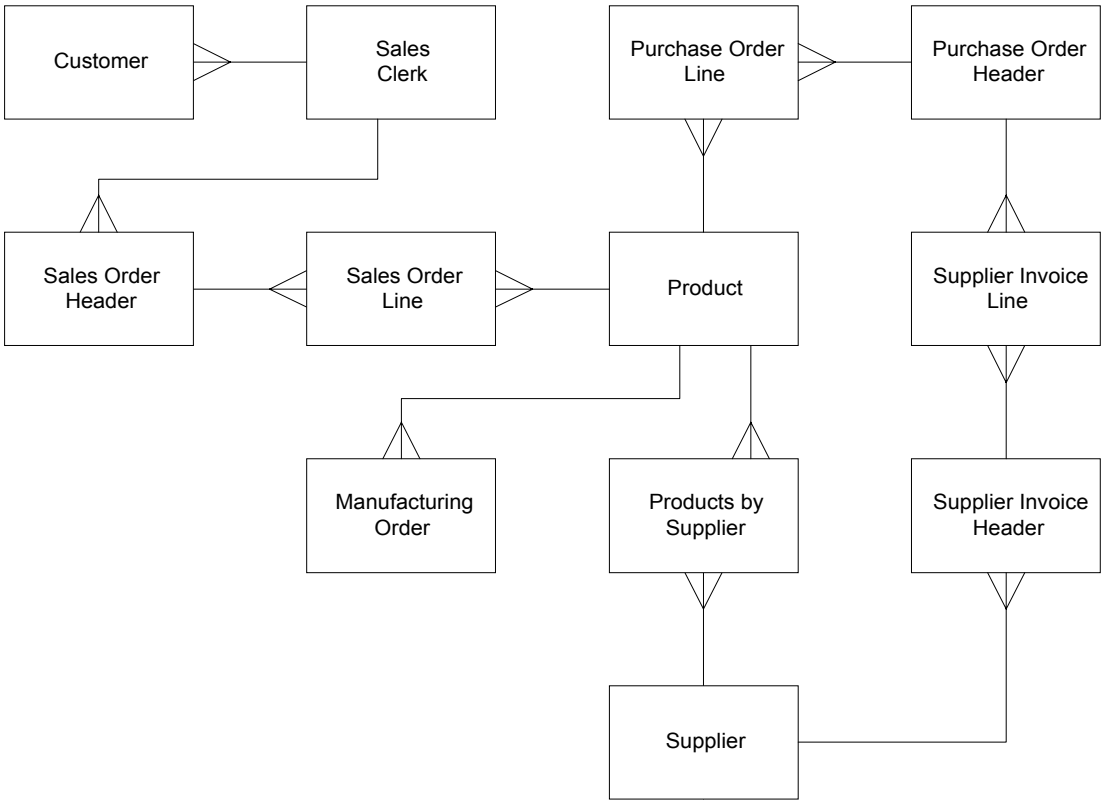
The relationships shown here assume certain enterprise or business rules. This is especially so in the case of the relationship between purchase orders and supplier invoices. It is possible to make different assumptions and come up with a different extent to the relationship (e.g. many-to-many, rather than one-to-many). The first cut diagram is shown below.



The many-to-many relationships for the Sales Order–Product link and the Purchase Order–Product link are clear from the forms illustrated in the case study. What is less clear is the nature of the relationship between purchase orders and supplier invoices. Students should be encouraged to think through the implications of each alternative relationship in business terms.

Final ERD

In the final version of the ERD, students need to remove all many-to-many relationships by introducing new linking entities (see diagram below).



Exercises (PP. 420 – 421)

Self-assessment exercises

1. What is the difference between the 'funnel' and 'pyramid' approaches to structuring an interview?

- *Pyramid structure.* This is where the interview begins with a series of specific questions and during the course of the interview moves towards general ones.
- *Funnel structure*. The interviewer begins with general questions and during the course of the interview concentrates increasingly on specific ones.

2. Why can closed questions still be useful in an interview?

Closed questions are designed to confirm the interviewer's understanding of information obtained. They can also be used to obtain quantitative data.

3. Assess the relative effectiveness of interviews versus questionnaires when attempting to establish user requirements

Interviews have the following benefits:
- the ability to gather detailed information through a two-way dialogue;
- they allow candid, honest responses to be made;
- an open, spontaneous process which can lead to valuable insights, especially when open questions are used;
- responses can be easily quantified, especially when closed questions are used;
- being one of the best methods for gathering qualitative data such as opinions, and subjective descriptions of activities and problems.

They can be ineffective if:
- The analyst's findings are likely to be coloured by his or her perceptions of how other, similar business operations work. Interviewers need to be especially skilled if this is to be avoided.
- Interviewees may not cooperate with the interview process, either by not taking part or by giving vague and incomplete replies, if the development of a new information system is perceived as a threat through the risk of de-skilling, redundancy or a perceived inability to cope with change.
- The interviewee tells the analyst what they think should happen in an existing situation rather than what actually happens.
- Staff at lower organisational levels may not be capable of articulating their requirements with sufficient clarity.

Questionnaires can be effective if:
- information from a large number of people needs to be gathered – this will represent a more efficient use of time than interviewing;

- the information gained is used to check the findings obtained from alternative fact-finding methods;
- information is to be gathered which needs to be tabulated or easily structured.

On the other hand, questionnaires:

- mean that respondents cannot go back to the analyst to seek clarification about what a question means;
- may make the collation of qualitative information difficult if the questionnaire contains open-ended questions – this would also be true of interviews, but there would be likely to be a larger number of responses to collate from a questionnaire;
- lack the ability to use verbal and non-verbal signals from the respondent as a sign to ask other or different questions;
- often have low response rates, although this is not such a problem for internal staff.

4. In an information flow diagram, why should we not record information flows that lie completely outside the system boundary?

In either an IFD or a DFD we are only interested in information flows or data flows that are within the scope or context of the system under consideration. For example, in the ABC case above, we have no interest in any flows between our customers and suppliers – it is outside both the scope of the system and the business as a whole.

5. What are the main differences between an information flow diagram and a dataflow diagram?

Whereas an IFD simply shows information sources, destinations and flows, a DFD also shows processes where inputs are transformed into outputs of some kind and datastores are present to show where data is held within the system. In addition, information destinations are re-termed 'sinks'.

6. What is meant by the term 'levelling' in dataflow diagrams?

Students need to understand that in a DFD it is difficult to show all the processes relevant to a system unless the system under consideration is very small. Levelling, therefore, allows processes to be identified at a very high level (e.g. process customer order), and then each process can be decomposed into subprocesses and activities on subsequent diagrams. To be accurate and successful, it should be possible to identify clearly how the processes of a lower-level diagram can be aggregated to recompose the higher-level process which generated it.

7. In a sales order processing system, which of the following are not entities? Customer, colour, size, product, telephone number, sales order, sales person, order date.

In this question, students need to distinguish between data items (or attributes) and entities. An entity can be defined as a collection of data items which together describe a person, place, thing

or event about which we wish to store data. The data items, therefore, are individual elements which carry part of the description for a particular occurrence of an entity.

Using these definitions we can look at each of the following:

- *Customer*: this will comprise a collection of data items such as name, address, telephone number etc. which together can be used to identify individual customers; customer is, therefore, an *entity.*
- *Colour*: this is an attribute which helps to describe an occurrence of something (e.g. a garment); it is a *data item.*
- *Size*: as with colour, it is a *data item.*
- *Product*: this will normally be an *entity* since it describes the characteristics of something that a business might sell; colour above might be one of the data items; also, students should not confuse product with product code or description.
- *Telephone number*: as suggested above, a telephone number would be a *data item* not an entity.
- *Sales order*: this would contain details such as order date, customer number, delivery date etc.; it is, therefore, an *entity.*
- *Sales person*: this can be interpreted both ways: if we are looking to store details about each sales person (sales this month, name etc.) then this could be regarded as an *entity*; if we mean the person who took an order, then it could be interpreted as a *data item.*
- *Order date*: as suggested above, this would constitute a *data item* and be part of the sales order entity.

8. Why might the construction of an ERD still be useful even if an off-the-shelf package was going to be purchased?

An ERD represents a logical data model for an organisation. Entities which contain data needed to support business activities are defined as are the relationships between them. A packaged solution needs to be able to represent the data required by the business and with the appropriate relationships. How the package's physical database is designed is a separate issue and should not affect the decision whether or not to buy a package provided that the relevant business operations can be supported according to the relevant enterprise or business rules. The ERD, therefore, can provide a conceptual framework with which to test the ability of the package to deliver what is required.

Discussion questions

1. Use a simple example with no more than five processes or ten information flows to examine the differences between the information flow diagram and the dataflow diagram. Which would be more effective for explaining deficiencies with an existing system to:
(a) a business manager
(b) a systems designer?

Justify your reasoning.

With this question it is helpful to give students some alternative examples around which to construct some sample questions. In addition to the illustrations in Chapter 11, consider the following possibilities:

- student book loans from a university library;
- recording and arranging employee training;
- a photographic developing and printing shop;
- a high street travel agency;
- a new car dealership.

It is not proposed to give solution examples here. However, you are advised to consult the relevant examples in Chapter 11 and the sample solutions for the ABC case study given above.

For a business manager, it is suggested that both diagrams are beneficial. An IFD will allow easy inspection of the major information flows within the business and, as with ABC, omissions or oversights are easy to spot. A DFD also has the benefit of presenting to a business manager the processes that have been identified within existing information. This can be compared with a DFD of the *required* system to identify processes that are missing or those that do not add value to the business. Similarly, an IFD of the required system could also be constructed and compared with an IFD of the current system.

For a systems designer, although an IFD is useful in putting the system in context, a DFD adds the essential elements of business processes and data. This will assist greatly in the understanding of the existing business processes. DFDs also act as a good communications tool between designer and user. Finally, DFDs are useful as both a completion check and a consistency check. In this way, the risks posed from faulty analysis and, therefore, design are reduced.

2. Compare the effectiveness of 'soft' methods of acquiring information such as interviews and questionnaires and 'hard' methods of gathering information such as document analysis and observation of staff. Which order do you think these analysis activities should be conducted in and on which do you think most time should be spent?

Students need to understand that, regardless of the fact-finding methods used, the object of the requirements determination exercise is to maximise the accuracy and relevance of the information gathered so that later stages of the systems development project are not subject to

unnecessary remedial costs. It is also important to distinguish between finding out what happens in the *current* situation and determining what is needed in the *new* information system.

Current System. A mixture of methods is appropriate here. One possibility is to begin by reviewing documentation and observing staff at work before carrying out interviews or conducting questionnaires. In this way, it will be possible to make the interviewing exercise more productive because the analyst already has a base of information from which to work. Interviews and questionnaires can be used to confirm the accuracy of the findings from the observation and documentation review exercises. On the other hand, one or two initial interviews may also be helpful in ensuring that the observation and documentation review is more focused and on target.

Future system. Facts about the current system will already have been gathered. In looking at requirements for the future system, interviewing, meetings and brain-storming sessions are likely to yield most benefit, although the information gained from analysis of the current system is also a valuable input into this process.

3. 'For producing a database, the only type of diagram from the analysis phase that needs to be produced is the entity relationship diagram. Dataflow diagrams are not relevant'. Discuss.

Students who agree with this question either do so because they don't like drawing DFDs, or because they have not made the connection between the datastores on an DFD and the logical database design that comes from an ERD.

It is perfectly possible to construct an ERD without having first drawn a DFD. However, this requires the students to almost pluck out of thin air those things about which they think data needs to be held. The datastores within a DFD can be used as part of a first cut ERD and using these helps in the first instance. However, it is possible that a DFD which only models *existing* processes may omit datastores that are needed in the required system. The question, therefore, almost becomes 'Is is necessary to construct a DFD of the *required* system as well as the *existing* one?

Strictly speaking, then, while it is possible to construct an ERD without first of all having a DFD as a basis, the DFD is helpful in documenting some of the findings of the analysis process.

Essay questions

1. Compare and contrast alternative fact-finding methods and analysis documentation tools as they might relate to bespoke software development and the purchase of off-the-shelf packages.

This question is asking students to analyse whether or not there are really any differences at all in the approach that should be taken to requirements analysis, dependent on the type of acquisition method envisaged. A systematic approach could take a selection of fact-finding methods and documentation tools and look at each one from a bespoke development and a package perspective. What follows is a summary of some of the points that may be raised:

Fact-finding methods
The assumption here is that in the case of the proposed purchase of a package an IS/IT professional will be carrying out the fact-finding process. However, in the case of a small business, there may be no such staff within the organisation. Indeed, for smaller organisations, the formal analysis stage may almost be skipped completely by simply constructing a list of key requirements based on the understanding of the business by the system's sponsor or owner (who may be the same person). The business may then move straight to the package selection task, using the requirements list as a checklist against which to measure what each alternative package offers.

The question arises as to whether or not larger organisations with IS/IT staff should still carry out a formal requirements analysis if packaged software is being purchased. Unlike a bespoke solution, the analysis stage will not be providing a requirements catalogue from which the system will be designed from scratch. However, it will still be necessary to have a clear understanding of the requirements before software is purchased. The emphasis in the fact-finding stage should, therefore, be geared towards gaining a sufficient understanding of the requirements so that a list of appropriate packages can be constructed and a short-list produced.

For bespoke development, the analyst is free to use whatever fact-finding methods s/he feels to be appropriate to the situation under consideration.

Documentation tools
As has been suggested earlier, the purpose of documenting the findings will be different, depending on the system acquisition method. When a package is being purchased, a DFD of the current business situation is worth producing because it will illustrate the business processes that may need to be supported. An IFD is also useful, because it will help to establish the scope of the system. As discussed above, an ERD can also be useful in ensuring that the package that is selected is capable of supporting the types of data and their relationships that relate to the business activities under consideration. Finally, a requirements catalogue is essential in order to provide a checklist against which package features can be assessed.

With a bespoke solution, the documentation of the analysis findings is an essential input into the design stage. Therefore, assuming traditional development methods, detailed IFD, DFD and ERD diagrams should be drawn.

2. Errors in the analysis stage of a systems development project are far more costly to fix than those that occur later in the systems development lifecycle. Why do some organisations seem to devalue the analysis process by seeking to get to the system build as quickly as possible?

This question has two aspects: first, the legitimate shortening of the formal analysis process by employing RAD techniques and second, the desire by some managers (business and technical) to see physical evidence that systems development is actually happening by the production of programs (whether they work, do what is required or not). The former is perfectly acceptable provided that it is part of a properly constructed RAD project. The second is unacceptable because it fails to recognise the importance of the analysis process and the increase in fixing costs as and when the developed system fails to deliver what is required.

In answer to this question, students should be encouraged to identify systems development projects that have succeeded using formal methods (either RAD or more traditionally developed systems) and also projects that have failed because of poor or incomplete analysis of requirements.

3. Compare and contrast the relative effectiveness of the use of information flow diagrams, dataflow diagrams and entity relationship diagrams by a business analyst to demonstrate inefficiency in a company's existing information management processes. Use examples to illustrate your answer.

The aim of this question is to make students think about the purpose of the different diagrams and whether or not they can be applied separately or need to be used in unison. A good answer should highlight the differences between the techniques and it follows that for a complete picture of a problem or solution a range of techniques is useful. Other techniques, such as flowcharts or context diagrams, may also be useful.
Summary of techniques:

- *Information flow diagram* – focus is on the flow of information between people in different departments of an organisation. Relatively simple technique that highlights inefficiencies such as duplication, bottlenecks and repetition. Limited information in relation to DFD.
- *Dataflow diagram* – includes information flow, but the focus is on *process* and separate datastores for information. This detail is needed for systems designers, but may be too complex to be understood by business users.
- *Entity relationship diagram* – focus is logical grouping of information into entities. Essential for database designers, may be less important to discuss with business users. This is has a completely different purpose to the other techniques so is a valid addition. Some overlap with datastores of DFD and entities of ERD.

The student should use a company case study and use the different techniques to highlight the differences between them.

Examination questions

1. Briefly review the arguments for and against using interviewing as a means of determining system requirements.

The following points are taken directly from Chapter 11. Students would normally be expected to be able to recall about three points on each side.

On the positive side they include:
- the ability to gather detailed information through a two-way dialogue;
- they allow candid, honest responses to be made;
- an open, spontaneous process which can lead to valuable insights, especially when open questions are used;
- responses can be easily quantified, especially when closed questions are used;
- being one of the best methods for gathering qualitative data such as opinions, and subjective descriptions of activities and problems.

On the negative side however, the following points can be made:
- the analyst's findings may be coloured by his or her perceptions of how other, similar business operations work. Interviewers need to be especially skilled if this is to be avoided;
- the development of a new information system may represent a threat through the risk of de-skilling, redundancy or perceived inability to cope with change. Interviewees may, therefore, not cooperate with the interview process either by not taking part or by giving vague and incomplete replies;
- the interviewee may tell the analyst what they think should happen rather than what actually happens;
- interview at lower organisational levels may not yield as much information as some other methods if staff in this area are not capable of articulating with sufficient clarity.

2. Explain the relationship between the initiation and analysis phases of the systems development lifecycle.

The initiation phase occurs at the very beginning of the systems development process where it is envisaged that a new information system may allow an organisation to take advantage of a business opportunity, improve its capability, reduce costs or respond to external events.
The analysis phase will take place once it has been determined that the system as envisaged is feasible. Analysis will require a detailed review of the business requirements.

3. Briefly explain (in one or two sentences) the purpose of each of the following diagramming methods:
(a) Information flow diagram
(b) Context diagram
(c) Dataflow Diagram
(d) Entity relationship diagram

(a) An IFD is designed to show a high-level view of the main information flows within a business. It does not attempt to show processes or datastores.

(b) This is a simplified IFD showing as a single box the system under consideration together with the external elements to which it relates.

(c) A DFD takes the basic IFD and adds to this processes (where inputs are transformed into outputs of some kind) and datastores (repositories of data which are used to support the business processes).

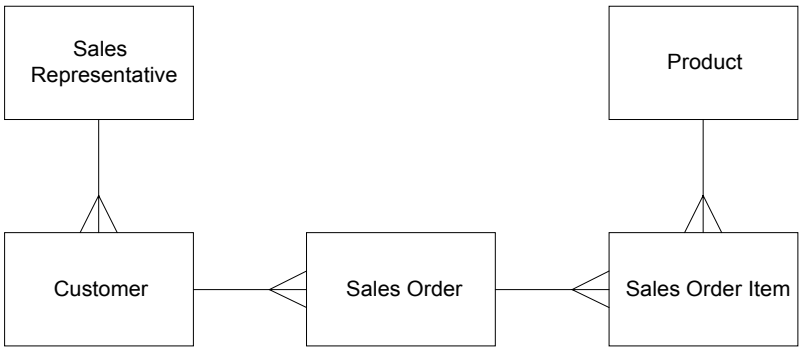
(d) In an ERD, entities are identified which will be used to define data used in the system under consideration. Relationships (1 to 1, 1 to many, many to many) between the entities are shown and can be used to construct a physical database design (ensuring that tables contain the necessary foreign keys to allow data to be linked).

4. Draw a diagram showing each of the following relationships on an ERD…

In this question, students have to draw a simple ERD. Most students find the hardest part is getting the crow's foot on the right end. To help this we ask the student to imagine themselves in the role of the object by 'standing in the box'. For example, as a sales representative will you deal with many customers? Yes. As a customer will many sales representatives be responsible for you? No.

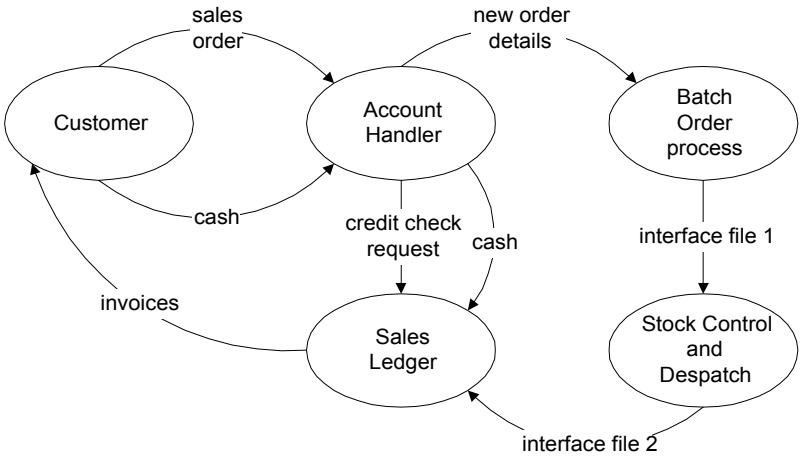
(a) The customer places many orders. Each order is received from one customer.
(b) The customer order may contain many requests for products. Each product will feature on many customer orders.
(c) Each customer has a single customer representative who is responsible for them. Each customer representative is responsible for many customers.

A possible answer is shown in the diagram below.



5. The final examination question is based on a case study: Megatoy Limited. The question is available from the companion web site.
(a) From analysis of the case study, produce an information flow diagram which summarises the current information flows within the company relating to sales order processing.
(b) From the information flow diagram produced in (a) identify problems in the current information flow.
(c) Assuming that Megatoy decides on an in-house developed bespoke solution for an information system to replace the existing system:
  (i) Which suitable fact-finding techniques could be used to implement the system? You should state which are most appropriate and explain why.
  (ii) Explain how a dataflow diagram would be useful to the designers of the system.
(d) Identify the main entities which would be necessary to store information to support the sales order process.

(a) The diagram below represents the information flow diagram for Megatoy case study, all flows are within system boundary.



(b) The main problem would seem to be the use of the interface files which means that credit check requests may or may not reflect the status of current customer orders.

It should be pointed out to students that one of the weaknesses of IFDs is that they give no impression of the timing of what happens when. If the updating of the sales ledger, new orders and despatch was done in real time, (in other words the interface files were really transaction files), the IFD would look very little different.

(c) The first factor to consider is the size of the company. With 230 employees a strategy is required that will involve the maximum number of staff while at the same time allowing the fact-finding exercise to take place as quickly and efficiently as possible. An appropriate mixture is:
- Meetings and brainstorming sessions to secure widespread involvement.
- Interviews with key personnel and a selection of staff from the relevant functional areas.

It is debatable if using questionnaires is appropriate in what is a medium sized business, but they could be of use for distributors since they show problems in customer service resulting from an existing system.

(ii) A DFD will allow analysts to construct a far more complete picture of the business than the simple IFD because processes and datastores will be added. It will become much clearer where processes exist that cause bottlenecks in the processing of data and decision making (the interface files, for example). It would be a mistake, however, just to construct a DFD of the *current* system. What is necessary is then to construct a DFD of the *required* system, so that unnecessary processes can be removed and business decisions supported more effectively. The DFD of the required system will also serve as a very useful communication tool when explaining the functionality and benefits of the new system to the end users.

(d) We have seen much of this before! The kinds of entities (students should be very familiar with these by now) should include customers; sales persons; sales order header; sales order line; product; sales accounts.