A Framework for the design of courses and the integration of those courses into a curriculum

A technical report submitted to the Faculty of Commerce, University of Witwatersrand, in partial fulfilment of the degree of Master of Commerce

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March 1994

ABSTRACT

Designers of both computerised information systems and instructional systems are faced with a need to find more effective methods of identifying and supplying the information that the users of these systems require. It is suggested that a transfer of selected information systems methodologies to instructional design would be of benefit. An entity relationship diagram is drawn up for a simple course and once decomposed and set up in orthogonal form is shown to be a useful tool for setting objectives, establishing modules and the learning sequence and listing topics.

A need in accounting education is the understanding of the nature of information systems and their development, use and control. A dynamic social and technological environment is changing the way accounting data is accumulated and accounting information is presented. This must impact on the teaching methodologies in the accounting courses.

A conceptual model of the roles of the accountant in producing accounting information is set up. This is broken down into a set of diagrams which facilitate the integration of an understanding of the nature, control, design and implementation of information systems into the respective courses. They also provides a model of the structure and sequence of those information system concepts and relationships relevant to the accountant.

Introduction

Naisbitt (1982) pinpoints the years 1956 and 1957 as the turning point, the beginning of the information age. Already at that time Drucker, (1958) was referring to an inexhaustible abundance of data and posed the question:

> *"But what has to be done to make this cornucopia of data redound to information, let alone to knowledge" (p. 12).*

Anyone who has the responsibility to provide information in both the fields of education and computer information systems will recognise that this problem still prevails.

Despite a growing stockpile of educational material, the education system is accused of producing an increasingly inferior product (Naisbitt, 1982, p. 32). Professions are contending that curricula have lost their relevance and the knowledge, skills and attributes of students are not being sufficiently developed (Carter, 1985, Williams, 1991). In the information systems field Shemer (1987) comments that much of the maintenance cost of computer systems can be attributed to the failure to identify the real needs at the design stage. In the design of both information and instructional systems, the fundamental problem is the clear identification of information needs.

Both instructional and information systems have been described as combinations of human and machine components designed to produce information or knowledge (Whitten et al, 1989, p.38, Rowntree, 1982, p. 12). In the computer field, the cycle of collecting, storing and processing data into information is well recognised (Whitten et al, 1989). An educational course, too, has a cycle consisting of inputs (course content), processes (instructional methods) and outputs (learning as measured by course objectives) (Romiszowski, 1981, pp. 37-41).

In an attempt to improve the definition of the information requirements of users, information system developers use structured development methodologies which follow a sequence referred to as the system development life cycle (SDLC). Structured information system development methodologies are formal procedures, techniques and methods for completing one or more steps of the SDLC. This proceeds from the general level of defining the problem, feasibility studies and systems analysis to the detailed level of systems design and implementation (Whitten et al, 1989; Wysocki and Young, 1990).

The stages of instructional design have not been defined as rigorously as those of the SDLC. Many educational authors describe a cycle of course development (e.g. Romiszowski, 1981, Rowntree, 1982, [illegible]geluth, 1983) while in the accounting field, Armitage and Boritz (1986) followed a six-phase sequence in their development of a framework for integrating computers into the accounting curriculum. These cycles, allowing for semantic differences, are comparable in the sequence and nature of the steps to that of the SDLC.

Due to the similarity of information and instructional systems and their development cycles, there should be much to be gained from a transfer between the design methodologies of these two systems particularly as there are similar problems in identifying information requirements.

It is contended that the intensive effort expended over the years to develop information system design methodologies has produced some which can be usefully applied to instructional course development. The first part of this paper proposes to identify some of those methodologies and to show the benefits of their application to the design of instructional systems. In the second part of this paper, selected information system development methodologies will be applied to develop a framework to incorporate an information systems understanding into the accounting curriculum.

Why Use Is Methodology?

Structured methodologies are formal procedures, techniques and methods for completing one or more steps of the SDLC. The structured approach to computer systems analysis and design has been advocated and promoted since the late seventies and is used by the majority of companies with a high level of satisfaction (Necco et al, 1987). Properly implemented, structured SDLC methodologies improve the efficiency, communication, control, role definition, documentation and consistency within systems (Wysocki and Young, 1990).

Much of the methodology of the SDLC consists of modelling the system using diagrams and charts. The technique of modelling has been used since the seventies to enable analysts to present clearly their ideas and understanding of the situation (Gane and Sarson, 1979). This can be contrasted with the many models of instructional design. Andrews and Goodson (1980) not only mention a "bewildering array" of models b also comment on the inadequacy of the description of some models which prec their use. Despite this, they point out the importance of using models in instructional design and the need for a systematic approach in education.

In information systems development, the different techniques and tools can be selectively applied with success (Avison et al, 1992). The successful transfer of selected aspects of information systems methodologies to instructional design should assist educationists in defining curricula and teaching objectives.

Modelling the system

In communicating the developer's understanding of the requirements of the system, the use of text has the potential to be vague and incomplete. To counteract this, information systems developers have used sophisticated modelling techniques. These have been found to be valuable for presenting ideas, aiding understanding and giving insight (Barker, 1990).

A model is a graphic analog of the physical properties of the actual or potential system being analysed and serves as a starting point for identifying possible solutions. There are two widely used information system analysis modelling techniques, the process oriented perspective (e.g. data flow diagrams) and the data oriented perspective (e.g. entity relationship diagrams) (Olle et al, 1988). Process models show the flow of data into, within and out of systems. These are best used when there is a regular and predictable pattern of data flows which can be represented in such a way that duplications are minimised. A data model identifies the things of importance in the system, known as entities or objects and defines the interactions between those entities.

The choice between the process or the data model for instructional design is facilitated by the consideration of two aspects of education. These are the nature of data flows and the importance of relationships between concepts.

In education the flows of data (i.e. the student-teacher interaction) are not regular repetitive flows as in information systems but differ according to the subject under discussion. Any attempt to model these flows is likely to result in excessive complication, absence of essential aspects or relationships insufficiently dealt with (Romiszowski, 1981). Thus process type modelling, such as using data flow diagrams, is not suitable for modelling instructional design.

The establishment of relationships between concepts and their use in teaching is important to course design and student understanding (Lawless, 1979). What is required is a model which looks at the concepts of the course, their attributes and the inter-concept relationships. These are referred to by Donald (1983) as the knowledge structure or core content of a course. The data model used in information systems development, identifies the entities of importance in the system and their attributes and defines the interactions between those entities. This meets the needs of instructional design.

The data modelling technique used in this paper is an entity relationship diagram based on Barker's (1990) approach. The entity relationship diagram identifies the significant entities in the system about which information needs to be known or held and defines the interactions between those entities. Entities are drawn as rectangles with rounded corners.

In an educational entity relationship diagram, the entities will be concepts, referred to by Duchastel and Steve (1983) as specific chunks of knowledge or by Donald (1983) as clusters of information. There is always a defined relationship between two entities. This follows the suggestion of Lawless (1979) that instructional models, which set up networks of concepts, often lack a further analysis of the relationships between the concepts. While Barker's (1990) system requires the definition of degree and optionality in the relationship, in this paper the relationship will only be named. Naming will be uni-directional working from left to right and from top to bottom.

Entities are further described by attributes or properties. Barker (1990) defines attributes as those properties that qualify, identify, classify, quantify or express the state of an entity. These are listed in each rectangle. In instructional design, attributes can be thought of as topics that amplify the concept.

Logical design

The concept of logical design is considered by some to be the most significant contribution of the structured information systems approach (Whitten et al, 1989). Setting up a logical design requires the definition of the overall information requirements before addressing how they will be met. This requires a change in conceptual thinking to approach the design from new directions rather than to adapt what exists (Whitten et al, 1989). The specification and structuring of the courses in a curriculum requires a new approach to avoid the influence of existing curricula. Using a similar approach to that of logical design, developers of accounting curricula have set up the ideal specification (Armitage and Boritz, 1986) or have utilised zero-based instructional design (Mock et al, 1991).

The first step in logical design is that of setting up a conceptual model. This model takes the form of an overview diagram derived by identifying and mapping only the significant concepts in the system and the relationships between those concepts. This overview diagram expresses the essence of the system and has similarities to the learning schemata (Donald, 1987), concept maps (Novak, 1990) or semantic nets (Fisher, 1990) which are used in instructional design.

There are often may concepts in a course, for example, Donald (1983) identified between 22 to 170 concepts in the sixteen courses she examined. A complete entity relationship diagram for a course may thus be complex. Entities can be drawn as summary entities (known as super-types) which contain further entities (known as sub-types). The use of super-types facilitates the preparation of the overview diagram. An overview diagram omits some sub-types, entities and relationships. These are incorporated when the model is broken down or decomposed into sub-diagrams each of which is a more detailed entity relationship diagram.

An overview diagram is illustrated (figure 1) by using the diet and nutrition course discussed by Rowntree (1982, pp. 129-131).

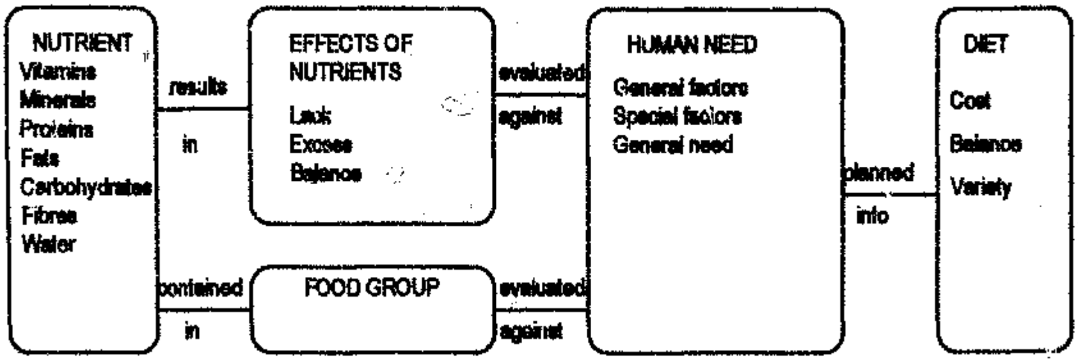

Figure 1. An overview diagram for a diet and nutrition course

By drawing an overview diagram and then decomposing the model into modules with predefined relationships, it is possible to change or integrate any module without affecting the whole course. This process of decomposition is a major tool of analysis and is important to the understanding of the complexity of a system (Booch, 1991, p. 14)

HIERARCHICAL STRUCTURES

Most of the hierarchical structures used in the design of systems are tree-like structures which do not sufficiently model the complexity of the system (Booch, 1991). While hierarchical structures model levels, they do not model the relationships at each level. Reti (1978) refers to the prerequisite relationships in the learning hierarchies of Gagné (1965) as being concerned pre-eminently with sub-ordinate and super-ordinate relationships and not with relationships between co-ordinate elements. He suggests that learning should not be based on a purely hierarchical pattern as there are relationships within as well as between modules.

The solution to this requirement is to draw a set of entity relationship decomposition diagrams. These decomposed diagrams will be placed into layers or classes with each class corresponding to a learning level. The set of diagrams are placed in orthogonal form combining class structure, which focuses on the intra-component relationships, and object structure which focuses on the inter-component relationships at each level (Booch, 1991, pp. 12-13). This is illustrated in figure 2.

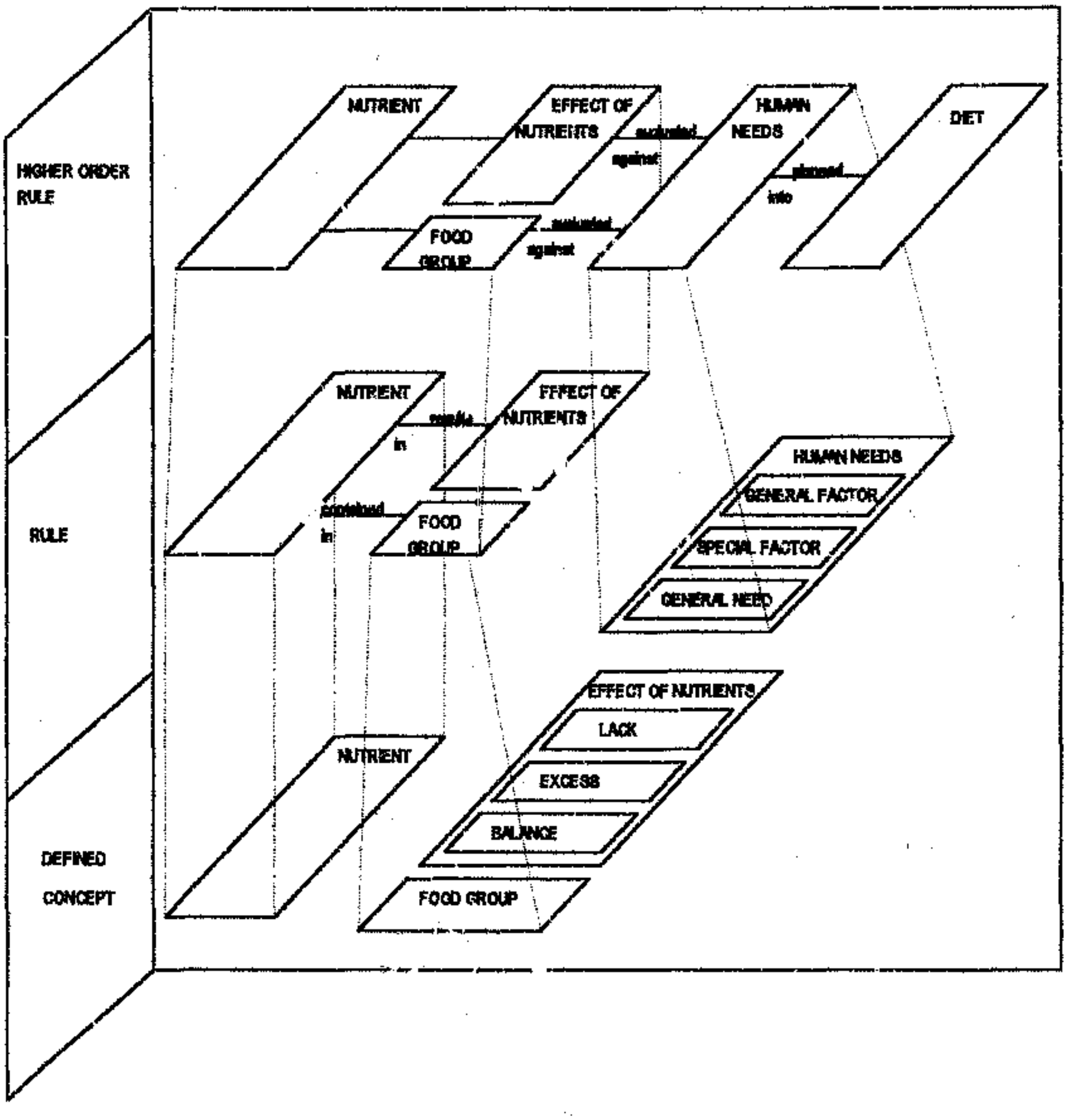

Figure 2. Decomposed entity relationship diagram's for a diet and nutrition course

The class hierarchy (shown on the left) is based on the three highest levels of Gagné's (1965) intellectual-skills category of learning. These are the levels of concept learning (identifying or classifying events, objects, or states and discriminating between their critical attributes); principle or rule learning (putting two or more concepts together in a relationship to form a rule and demonstrating the application of those rules); problem solving or higher order rule learning (recalling previously learned principles or rules and generating new higher order rules to solve a problem) (Gagné, 1965). Bloom's (1956) taxonomy was not used as it has been found to be less suitable for defining objectives at the macro design level (Carter, 1985).

The interrelationships between the concepts at each level are shown by the respective concepts at each level, as defined by their attributes, and the relationships between those concepts. At each higher level the relationships are more complex as they include the prerequisite knowledge of a lower class.

At the lowest level, the concepts of 'nutrient', 'effects of nutrient' and 'food group' are dealt with as entities with their sub-entities and attributes. These are taught at the defined concept intellectual skill level.

Once the concepts at the defined concept class level are taught, the entity of 'nutrient' is integrated with those of 'effects of nutrient' and 'food group' taking into account their respective relationships. After dealing with the entity of 'human need' and its sub-entities of 'general factor', 'special factor' and 'general need' at the 'rule' level, integration takes place at the higher order level taking into account all the entities, attributes and relationships.

This method caters for relationships within as well as between levels and is of benefit to the overall structuring of the course particularly with the identification of modules. Not only are there benefits to teachers in the clear modelling of the course, but benefits could also be gained by conveying the structure to students (Lawless, 1979, Reti, 1978).

DEVELOPING MODULES, COURSE SEQUENCE, OBJECTIVES AND TOPICS

The information system designer's concern is the specification given to the programmer for implementation (Whitten et al, 1989). These have two major elements: modules and the programming for each module. The more thorough and complete these are, the less clarification the programmer needs and the smaller the likelihood of problems (Whitten et al, 1989, p. 653).

In instructional design, detailed specification of each module helps to avoid later problems. This applies particularly where implementation is left to less experienced teachers (Roopchand and Moss, 1988). The decomposed entity relationship diagrams lend themselves to modularisation as each super-type or pair of super-types with their relationships tend to form a module.

As the concepts (entities) and relationships at each level form the prerequisite knowledge for the next level, the lower the item on the hierarchical diagram, the earlier it should be discussed. The set of entities at a level has an internal relationship and the complete set should be dealt with before moving to a higher level. This helps to establish course sequence.

While information systems design methodology does not assist directly in setting objectives, there is an indirect method from the entity relationship diagram model. Working from the bottom of the hierarchical structure, the learning at each successive level would be defined by the process of first discriminating between the attributes of each entity and combining these attributes into concepts. Once this is done the process is that of identifying and applying the relationships between the concepts, taking into account the class levels. The use of a taxonomy such as that of Gagné (1965) or (Bloom, 1956) tends to produce objectives which are more cognitive as one proceeds up the hierarchy (Duchastel and Steve, 1983). At the same time, the nature of the relationships between entities will move from concept formation or knowledge towards the formation of higher order rules or evaluation.

For this discussion, the complete diagram together with its attributes is needed. This is shown in figure 3.

The teaching objectives at the lowest level would be for the student to:

- describe the nutrients found in food;
- describe the functional and dysfunctional effects of nutrients distinguishing between the effects of a lack, an excess and a balance of nutrients;
- describe the different food groups.

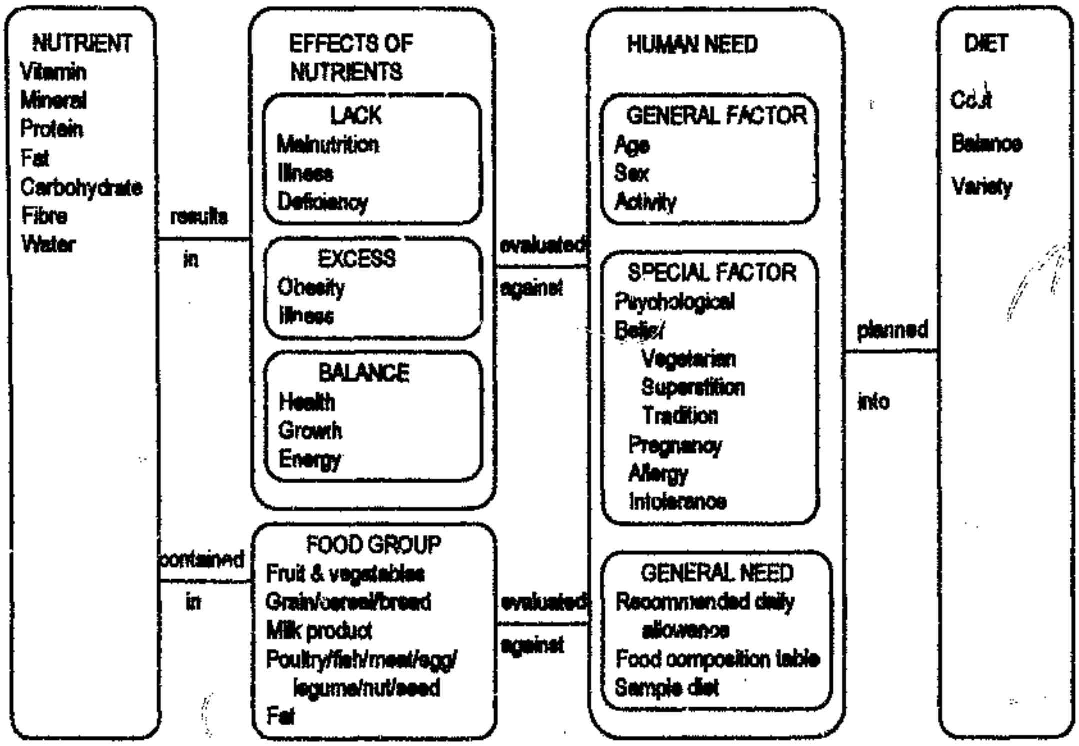

Figure 3: Detailed entity relationship diagram for diet and nutrition course

At the rule level of learning the first tteaching objectives would be to address the human needs diagram placed lower on the decomposed diagram (figure 2). These would be for the student to:

- discuss the general dietary needs of humans.
- discuss the general and special factors to be taken into account in satisfying human dietary needs;

Still at the rule teaching level, the next teaching objectives would be for the student to:

- Show how combinations of nutrients result in the functional and dysfunctional effects already learnt;
- Show how the nutrients are contained in the different food groups already learnt.

At the highest level the teaching objective would be for the student to:

- discuss the formulation of diets taking into account the evaluation of the effects of nutrients and food groups against human needs and planning these to achieve optimum cost, balance and variety.

The attributes of each entity will identify the main topics to be covered. It will usually be necessary to break down these attributes into sub-headings and even to draw further entity relationship diagram's to facilitate integration into the respective courses by providing a clear and understandable model of the structure and sequence.

Application

Since the Bedford Committee Report (AAA, 1986) there has been an increasing call for a broader perspective on the education of the accountant. Despite this, there is concern about whether education is correctly addressing the needs of the accounting profession and whether the knowledge, skills and attributes of accounting students are being sufficiently developed (Mayer-Sommer, 1990; Williams,D. 1991).

A particular need highlighted by the Bedford Report (AAA, 1986) is an understanding of the systematic collection, development and disclosure of accounting information for decision-making. To this end, the report maintains, future accountants should understand the nature, design, and implementation of information systems.

A source of discussion and disagreement has been the definition of the ways in which computers can be incorporated into accounting education (Bhaskar, 1982, 1983; Collins, 1983; Er and Ng, 1989; Collier et al, 1990). Much of the discussion has focused on the effectiveness of the use of computers as a learning or computational tool. This focus is narrow and fails to take full account of the implications of producing accounting information in a changing environment (Collins, 1983; Collier et al, 1990; Williams, 1991).

Changes in both the social and technological environments have resulted in new criteria for the reporting of both external and internal accounting information (Elliott, 1992). Traditional accounting systems have been criticised for inappropriate classification schemes, too high an aggregation level for financial information and insufficient integration with the information systems of other functional areas of the organisation

(McCarthy, 1982; Elliott, 1992). Information technology is providing the solution to this problem and organisations are implementing centrally controlled databases and incorporating accounting systems into integrated computer-based systems (McCarthy, 1982; Williams, B. 1991; Elliott, 1992). This enables the organisation to manage its accounting data so as to provide information tailored to a wide range of users with diverse needs (McCarthy, 1982). The accounting information system can no longer be described merely as the system for the processing of transaction data and but rather as the manual and computerised system for accumulating and communicating information about the economic events of an organisation (McCarthy, 1982; Elliott, 1992).

This broader view of the accounting information system implies that the study of this system should addre[illegible] many of the curriculum proposals made to date (Williams, B. 1991). [illegible] an understanding of information systems is fundamental to all the co[illegible]ing curriculum. Despite this, the emphasis has been on computer related skills with implementation taking place at the individual course level and not at the overall departmental level (Armitage and Boritz, 1986).

This section of the paper develops a framework for integrating an understanding of the nature, design and implementation of information systems into the accounting curriculum. This framework spans the requirements at all levels and within all accounting subjects. It is suggested that this framework will establish the use of information systems as an integral part of the accounting curriculum.

Conceptual model

For the purpose of this paper, the conceptual model (figure 4) is derived from the roles of the accountant in providing and using accounting information and from the nature of the information provided. There is a precedent for using roles to analyse courses in the professional environment (Romiszowski 1981; Duchastel & Steve, 1983). Davis (1987) listed seven roles which he used to define topics on information systems important for professional education.

The accountant is a member of the management team that has a responsibility to prepare and present the financial statements of the organisation (IASC, 1988, Section 11). A primary role of the accountant in that team is that of the preparer of financial statements. Parker (1982) refers to this role as that of the gatekeeper who has a critical influence over the nature, content and amount of information communicated to external users.

The Accounting Standards Board (1991) considers the primary characteristics of accounting information to be reliability and relevance. For information to be reliable it should be free from material errors or bias and complete. Lack of timeliness could limit the level of usefulness of the information. This places a responsibility on the accountant, as the principal user of the accounting information system, to ensure that there the information system is adequately controlled, designed and implemented to produce accurate, complete and timely information within the overall constraint of cost effectiveness. The accountant, both as preparer and as auditor, needs to evaluate the efficacy of preventive, detective and corrective controls in the accounting information system. The accountant, as principal user, should also participate in the development and implementation of information systems and monitor the ongoing processing (Davis, 1987; Stambaugh and Carpenter, 1992).

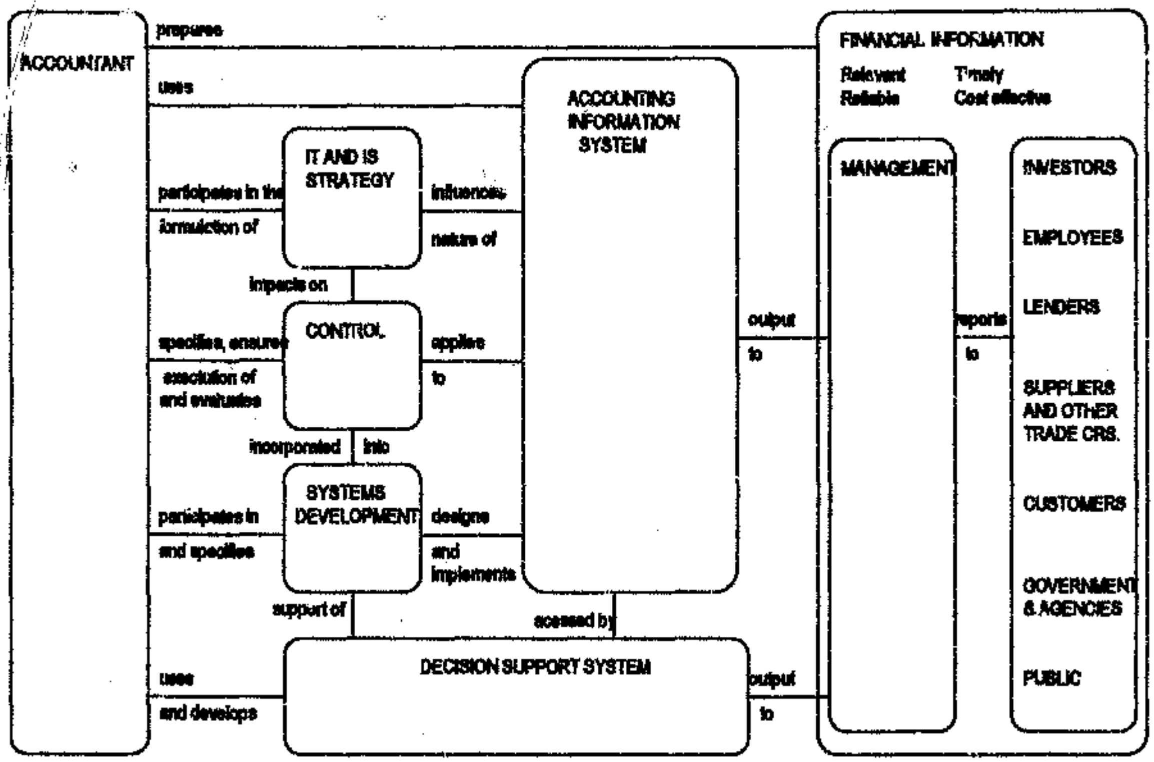

Figure 4: Conceptual model of the roles of the accountant in providing accounting information

Financial statements provide information on the financial position and the performance of the organisation to a range of users: investors, employees, lenders, suppliers and other trade creditors, customers, government and their agencies and the public (IASC, 1988). This information is relevant when it influences the economic decisions of users by helping them to evaluate past, present or future events or by confirming or correcting their past evaluations (IASC, 1988, Section 25).

Conventional accounting models have been criticised for limiting their measurements to transactions expressed in monetary terms (AAA, 1969, 1971). This precludes the incorporation of some performance and non accounting data. Although financial statements are usually prepared in accordance with the historical cost accounting model, the IASC (1988) framework allows that other models may better meet the objective of providing information for economic decision making (Cairns, 1988). Accounting systems are being developed to provide information to the wider range of users and, increasingly, information on non-financial transactions is being included in financial statements (Geerts and McCarthy, 1991, Elliott, 1992). There is a trend to relational-based data management systems which include external data relating to markets, and economic and social environments (Stambaugh and Carpenter, 1992; Elliott, 1992). This places a greater responsibility on the accountant to understand the nature of a database, how to maintain the integrity of the data and how to use decision support tools to access the information. Similarly, auditors should understand the methods for accessing and processing the data required for the audit (Davis, 1987).

While an effective accounting information system is necessary for "stewardship" there is a similar internal need to provide management information (Gordon et al, 1978). This internal information is generally agreed to be at three levels: strategic decision making, managerial decision making, and control and transaction processing (Anthony, 1965). While the conventional model caters for control and transaction processing, it is criticised for lack of timeliness and the inability to collect sufficient non-financial and external data (Bitner, 1991). The accountants are then criticised for failing to provide relevant information for managerial decision making (Johnson and Kaplan, 1987).

Increasing numbers of organisations are using information technology to gain competitive advantage (Tavakolian 1989). Organisations are outsourcing, or rightsizing according to their needs. This has an influence on the nature of the processing and controls required. Strategic information systems planning has resulted in information systems being aligned with overall business needs (Earl, 1993). As a result, the accounting information system is no longer considered a transaction processing system and is part of the overall strategic information system (Gordon et al, 1978). The input of the accountant is needed in formulating IT strategy and strategic information systems planning.

The accounting information system should be flexible, facilitate detailed analysis and summary and interface with the information systems of other functional areas (Stambaugh and Carpenter, 1992). In designing an accounting information system, it is important that the analyst understands these multiple requirements. Information systems developers frequently do not understand the nature and complexity of the accounting system and require the assistance of the accountant in its analysis and design (Stambaugh and Carpenter, 1992; Garceau et al 1993). If the accountant does not have some expertise in systems development, it may be difficult for him to meaningfully participate in the definition and design of a system (Den Hartog and Wielinga, 1992).

The conceptual model (figure 4) sets out the six roles of the accountant in providing relevant and reliable information. If the accountant treats the computerised information system as a black box and leaves its development, control and implementation to the information systems specialist, he has in effect abdicated much of the responsibility for producing reliable and relevant accounting information. As Elliott (1991, p. 3) puts it:

> *"The information era should be ours, because we accountants are the 'information people'. We are the ones that know - if we apply our skills generically - how to define information needs; design measurement techniques; control information capture and processing; and analyse, interpret and present information".*

The detailed model

The conceptual model (figure 4) contains those entities and their relationships that are perceived to express the essential features of the roles of the accountant in preparing accounting information. To identify modules for integrating into respective courses, the overview diagram is decomposed into detailed diagrams into which some of the omitted sub-types, entities and relationships will be incorporated (figure 5). These diagrams will be placed into layers or classes with each class corresponding to a learning level.

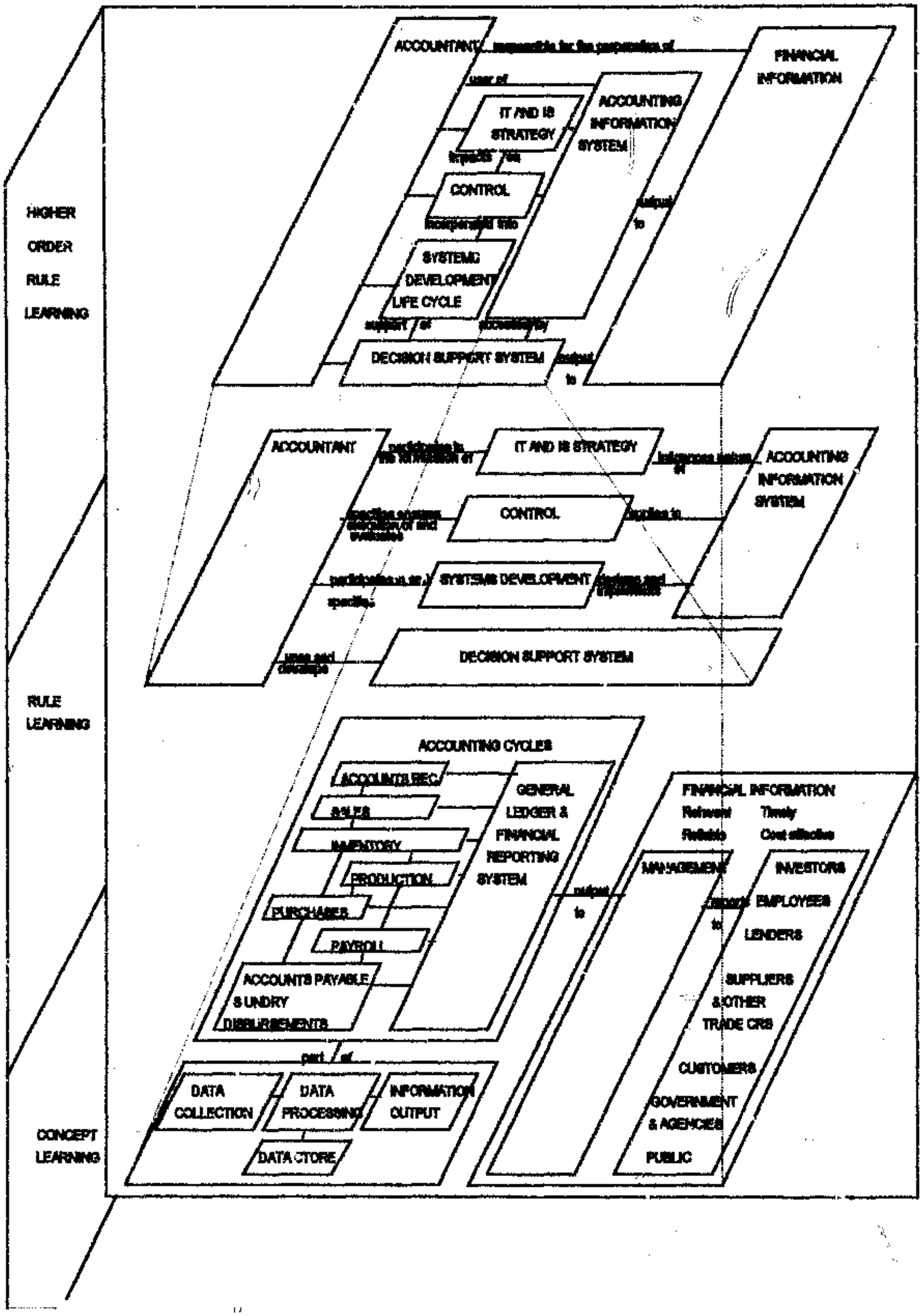

Figure 5: Illustration of the decomposition of diagrams into orthogonal form

Accounting cycles at the concept and rule learning levels

The first of the three diagrams (figure 6) is placed partly in the concept learning level and partly in the rule learning level. At the lowest level, the overall teaching objective is for the student to:

- identify and classify the characteristics of manual and computerised information systems and discriminate between their major components and methods of operation.

This objective is similar to the first objective of Armitage and Boritz (1986) at their level of introductory conceptual knowledge. Their focus on EDP systems has been expanded to include manual systems. Arens and Ward (1984) found it important to provide students at an early stage in accounting with an understanding of the operation of manual record keeping systems and their related documents and records. This has been recognised in the recommendation of the Bedford Report (AAA, 1986) that both the traditional accounting system and a computer-based system should be learnt.

Both the manual and computer information systems are shown as being part of the accounting cycles at a higher learning level. This leads to objectives that combine concept learning and rule learning. The student is required to identify and distinguish between the elements of the accounting cycles and to integrate these elements to understand and discuss:

- the accumulation of transaction data in each cycle and the transfer of this data into the general ledger and financial reporting system;
- the use of the data in the general ledger and financial reporting system to produce financial information for management and other users;

- the nature of typical accounting cycles including the sources of data relevant to each cycle, the functions of that cycle, and the information outputs;
- the interaction between the accounting cycles, which make up the financial information system of the business.

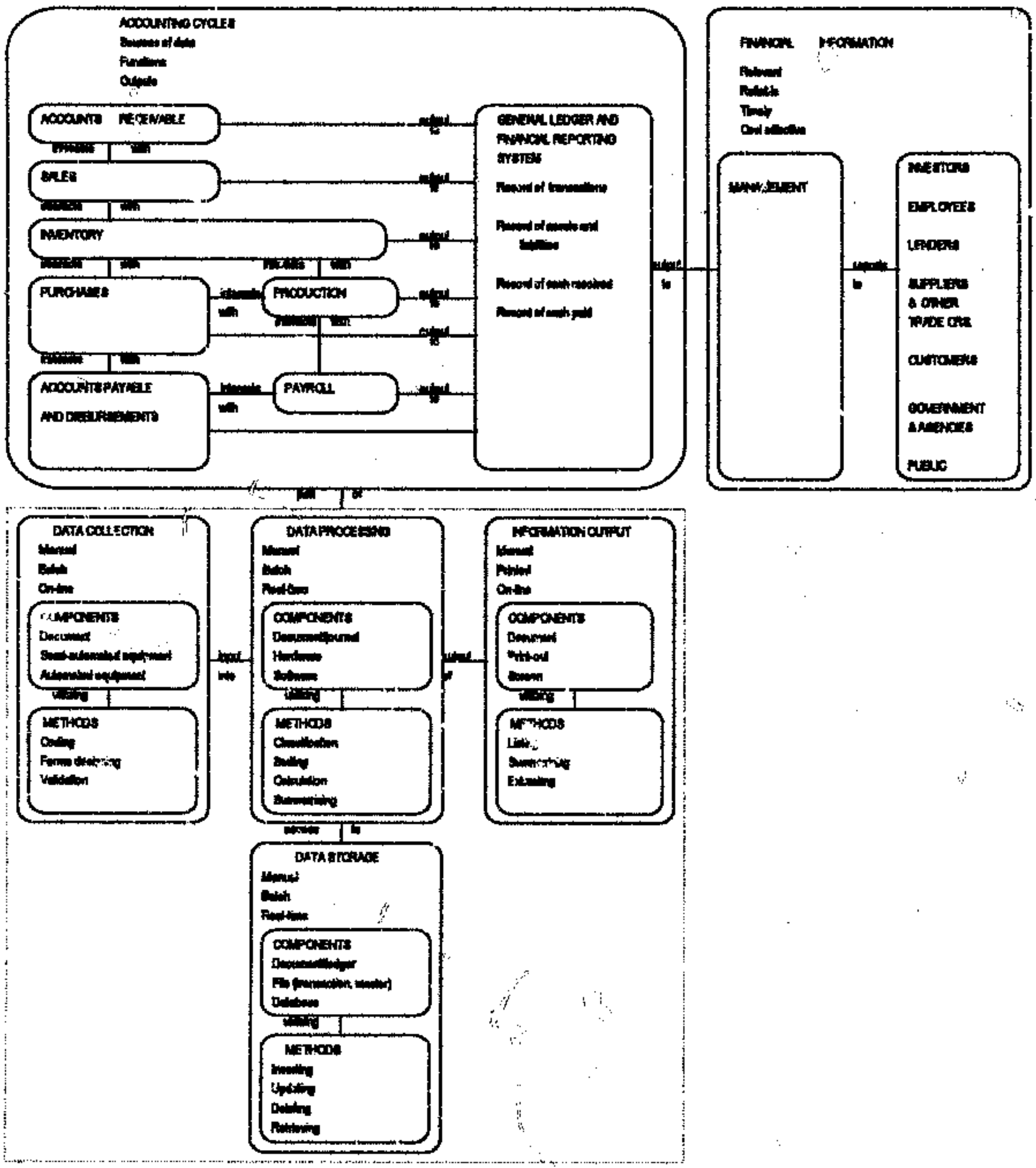

Figure 6: Detailed diagram at level one

The roles of the acccuntant at the rule learn!ng level

The main relationships at this level (figure 7) are the roles of the accountant in participating in the formulation o... ...ategy, in ensuring the development and execution of controls, in participating in and specifying systems development and as user and developer of decision support systems. The four key concepts of strategy, systems development, controls and decision support systems are identified in terms of the overall role of the accountant as the user and developer of the accounting information system. It is likely that elements of the diagram at this level will be discussed in different courses. For this reason the relationships between the four concepts are omitted in the diagram at this stage. These relationships will be incorporated at the next level.

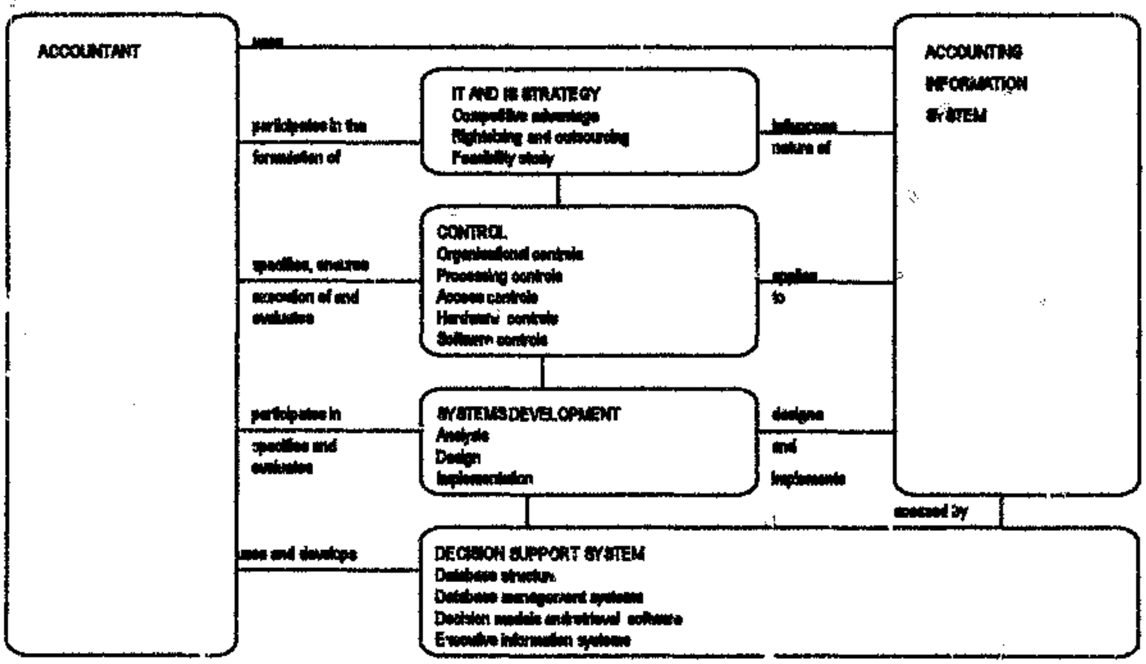

Figure 7: Detailed diagram at level 2

IT and IS strategy

Insufficient emphasis is placed on teaching accountants the strategic use of information technology in business (Elliott, 1991). Organisations are choosing technology and designing systems to give themselves competitive advantage. Often the strategic implications take precedence over traditional accounting procedures. Organisations are becoming more complex and yet more adaptable and require information systems that are able to cater for this (Druker, 1988). They are adapting the size and nature of their computer configurations to their needs. The choice of new systems is a thus a complex process (McFarlan, 1981) and the assessment of the cost-benefit and risk often requires the contribution of an accountant. The teaching objectives for the entity of strategy together with its relationships is for the student to understand and discuss:

- the nature of IT and IS strategy;
- the impact on the accounting information system of the technology and systems chosen;
- the estimation the benefits of implementing IT and the calculation of the cost benefit decision.

Controls

Accountants cannot represent that the financial or management information they have prepared is reliable unless they have an understanding of the accounting information system and the concomitant controls (Davis, 1987). Controls, particularly in the computerised information systems environment are commonly covered in auditing courses (Armitrage and Boritz, 1986; Er and Ng, 1989). The objective for this section thus includes both computerised and manual accounting information systems and includes the accounting as well as the audit aspects. The teaching objective for the entity of controls together with its relationships is for the student to be able to:

- specify, ensure execution of and evaluate organisational, processing, access, hardware and software controls in accounting information systems.

Systems development

Systems analysts often do not understand the nature of accounting information systems and the accountants' vocabulary (Stambaugh and Carpenter, 1992). The complexity of most information systems is such that formalised methodologies are needed to define and specify the requirements (Garceau et al, 1993). A lack of understanding of systems development methodologies on the part of the user will result in little influence on the development process in which they are supposed to play an important role (Den Hartog and Wielinga, 1992). Accountants do not need a detailed knowledge of systems development methodologies but need an understanding of the principles and the relationship of these to the development and implementation of the accounting information system (Williams, B. 1991). Gordon et al (1978) list as the design parameters of an accounting information system: identification of the information preparer, the recipients of the information, the technology employed and the specification of the information characteristics. This places the emphasis on the analysis phase of the systems development life cycle.

There is some contention that accountants should learn to program and that this assists in the development of logical reasoning skills (Bhaskar, 1982). The role of programming in the development of reasoning skills and the transfer of these skills to other disciplines has not been proven (Armitage and Boritz, 1986; Jansson et al, 1987). Further, Cronan and Fries (1986) in a survey of 111 universities found that most did not consider programming to be an important requirement. In a survey of 351 accounting graduates, Bean and Medewitz (1987) found that programming was rated the least important computer skill to a professional accountant. Collins (1983), however, argues practically for 'a modicum of programming instruction' (p. 314). He contends that without this skill it is difficult for the student to obtain a realistic understanding of the inter-relationship between input, language, hardware and output.

The implementation of a system is influenced by the organisational context and the existing control systems (Ginzberg, 1980, Den Hertog and Wielinga, 1992). The successful implementation of an accounting information systems is important to the accountant. This needs the involvement of the accountant who is able to evaluate the accuracy and completeness of the output. The teaching objective for the entity of systems development together with its relationships is for the student to be able to:

- participate in and specify the requirements for the systems analysis phase of the development of accounting information systems, using information system development methodologies;
- understand the nature of systems design;
- participate in and evaluate the implementation of accounting information systems.

Decision support system

Organisations are moving increasingly to the use of data bases. Accountants need to extract data from the data base for analysis and interpretation. To do this they need an understanding of data base structures and database management systems (Davis, 1987).

This ability is of importance to the auditor to analyse the effect of transactions and the nature of controls, in particular data base integrity controls.

Because it is now possible to directly access databases and use the processing power of the mainframe or file server, there has been a rapid growth in the use of decision support systems (King et al, 1990). In each of the main subject areas, i.e. financial accounting, managerial accounting, auditing and taxation, there is a need be able to use decision support software, retrieval software and expert systems and design forecasting, statistical and simulation financial models (Armitage and Boritz, 1986; Davis, 1987; Er and Ng, 1989; Collier et al, 1990; Simmonds, 1992).

Accountants are well equipped to identify relevant financial information. Because of this they should play a key role in the development of executive information systems (Stambaugh and Carpenter (1992).

The teaching objective for the entity of decision support system together with its relationships is for the student to be able to:

- discuss and understand data base structures and database management systems;
- use decision support and retrieval software
- design models for tax planning, and financial and managerial accounting decisions;
- participate in the development of executive information systems.

The overall application of the information system to financial reporting

At the higher order rule learning level, the model is the conceptual model (figure 4). At this level, higher order thinking skills are developed. Mayer-Sommer (1990) lists among the cognitive components of higher order thinking skills

> *"knowledge of facts, concepts, and procedures along with an understanding of the general and special conditions affecting the use, interpretation, and interrelationships of these facts, concepts and procedures". (p. 131)*

Since it is likely that the concepts at the first two levels are discussed in different courses, the overall application of these concepts for the reporting of financial information warrants consideration.

An information system can have a profound effect on organisations affecting structure, communication patterns and management style (Drucker, 1988). As management information systems become more integrated, the accounting information system is contained within and is influenced by the overall system. This has resulted in integrated databases and database management systems of which the accounting system is a part (Williams, B. 1991).

Users of the system who compete for computing resources include human resources, production, and marketing personnel as well as the accountant. To expedite their demands, end-users have learnt how and when to use systems and support tools to manipulate their own or extracted data (Price, 1991; Stambaugh and Carpenter, 1992).

This emphasises the need to safeguard the integrity and completeness of the accounting data within the overall information system (Leech and Mepham, 1991).

The trend is towards the control of organisation wide management information systems by chief information officers who report to the chief executive officer. The accountant is required to fulfil the overall responsibility of preparing relevant and reliable information. This may not be achieved if he does not participate in the choice of technology, the development of systems and the incorporation of controls.

This section integrates the concepts and the relationships between those concepts in the overall model (figure 4). This will require teaching strategies such as case studies which are already a common approach in the teaching of information systems to accountants (Libby, 1991). The teaching objectives of this section are for the student to be able to discuss and understand:

- the impact of IT and IS strategy on the nature of the organisation, its structure and controls;
- the impact of advanced technology on the accounting information system;
- the incorporation of controls into the development of new systems and changes to existing systems to ensure the production of reliable information;
- the identification and rectification of problems in the system which could impact on the relevance and reliability of financial information or prevent the production of information in a timely and cost effective manner;
- the recognition and utilisation of systems or technological opportunities to improve the preparation of management and financial information.

CONCLUSION

Designers of both information and instructional systems are faced with the problem of finding more effective methods for identifying information needs. As both systems are comparable in process and development, it was contended that transfer between the respective development methodologies is possible.

The use of logical design to break away from existing systems requires a modelling technique and a simplified form of the entity relationship diagram was found to be appropriate to the design of instructional systems. The problem of hierarchical patterns not taking account of inter and intra module relationships was solved by setting up decomposition diagrams in orthogonal form.

The well developed method of entity relationship diagram modelling in information systems design caters effectively for many elements of instructional design. Reti (1978, p. 33) sought a framework for stating objectives that provides for a progressive overview of the inter-relationships between the elements of a course as it develops. The decomposition of an entity relationship diagram provides this framework by deriving objectives, learning sequence and topics at each learning level and identifying modules which can be developed independently. This easily learnt methodology is valuable for modelling concepts and organising knowledge.

There is a call for a broader perspective in the education of accountants. A dynamic social and technological environment is changing the way accounting data is accumulated and accounting information is presented. This must impact on the teaching methodologies in the accounting courses. For the accountant to produce relevant and reliable information, the nature of information systems and their development, use and control must be understood. However, many of the curriculum proposals to date fail to take full account of the implications of producing accounting information in a changing environment. A conceptual approach to an understanding of information systems is needed to go beyond the teaching of basic skills in computing (Armitage and Boritz, 1986). The focus should be on the education of students rather than the training of them for the profession (Collins, 1983; AAA, 1986).

A conceptual model of the roles of the accountant in providing financial information was set up. This model was decomposed and presented in orthogonal form to set objectives and establish teaching methodologies. Time constraints in the accounting curriculum may reduce the ability of institutions to address all concepts. The logical design should, however, be of assistance in identifying those concepts which must be addressed and those which may be omitted.

It is no longer relevant to consider accounting information systems in isolation from other accounting subjects (Collier et al, 1990). Using the entity relationship diagram to model the roles of the accountant in providing financial information facilitates the integration of an information systems understanding into the respective accounting, auditing or specialised accounting information systems courses. It also provides a clear and understandable model of the structure and sequence. Not only are there benefits to teachers in the clear modelling of the course, but benefits could also be gained by conveying the structure to students (Lawless, 1979, Reti, 1978).

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