Implementing Integrated Information Systems in Construction Organisations

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ABSTRACT

The introduction of information systems into construction companies to facilitate the organisation and management of construction is often carried out on an ad hoc basis. Stand-alone applications are often employed in providing computerisation for specific functions and tasks in order to improve efficiency in the generation of information. Quite often this results in short term benefits, but can create problems as organisations grow and integrated information demands become greater and more complex.

Without consideration of adequate information technology strategy, the benefits to be gained from the integrated approach are not always fully realised.

To successfully implement integrated information systems, several issues must be considered. This includes the identification of both problems and user requirements to allow the establishment of a specification for the design and eventual implementation of a new information system.

Important considerations during this procedure must also include a company's organisation structure and culture, together with company operating characteristics. People within an organisation are also influential to a system's success, and correct training and user involvement at the analysis and design stages are important to the eventual acceptance and success of a system.

One method of integration is illustrated, together with the procedures and issues to be addressed. System maintenance and enhancements for expansion of an integrated information system are also considered.

Key Words
management; information systems; implementation; integration; data transfer; information generation

INTRODUCTION

The construction industry has been slow in its implementation of information technology compared with other industries. The general tendency, particularly in small to medium sized construction firms, has been to invest in standard application software designed for a particular process. Situations develop

in organisations where departments use dedicated software to suit particular modes of working.

Whilst this approach has satisfied an immediate need, further demands and calls for more complex data transfer and complex information systems generally follow. This is where problems can occur and departments become locked within their own operations. Data can be down-loaded to some appropriate storage medium which can then be sent to other departments. But the data format may not be in a compatible form to load directly into another department's software package, and may, in fact, have to be entered manually, resulting in lost time and duplication.

To avoid such an occurrence, and to satisfy such a need for data transfer and information generation, one alternative is to develop an integrated system to suit an organisation's requirements. This involves the analysis, design and implementation of an information system, which is capable of expansion to cater for future growth and the demands placed upon it.

SYSTEMS ANALYSIS WITHIN AN ORGANISATION

Before a integrated system can be designed, present systems within an organisation must first be analysed and documented. This can take the form of a systems analysis using data flow diagrams to illustrate the overall operations of a company, followed by analysis at departmental level, based on the top-down approach (Stephenson and Oxley, 1985). Additional tools can be introduced to support the analysis where appropriate, including levelled data flow diagrams, data dictionaries, decision trees and process logic (Gane and Sarson, 1979; DeMarco, 1979). A typical example of a context data flow diagram illustrating top level data flow is shown in figure 1.

The added advantage of the systems analysis work is the identification of deficiencies which may not have been realised. From the documentation of data flows and user requirements, it is possible to identify data interfaces between management functions. It should therefore be possible to establish:

* data in its original form
* data which needs amendment to suit tasks and to be presented in a suitable format for processing purposes
* data which is redundant
* data which is repetitious
* the extent of new data created by management functions

The identification of man/machine boundaries and data transfer requirements can be determined. Changes in methods of operations may also be possible through the utilisation of information technology. Revised documentation can therefore be produced to

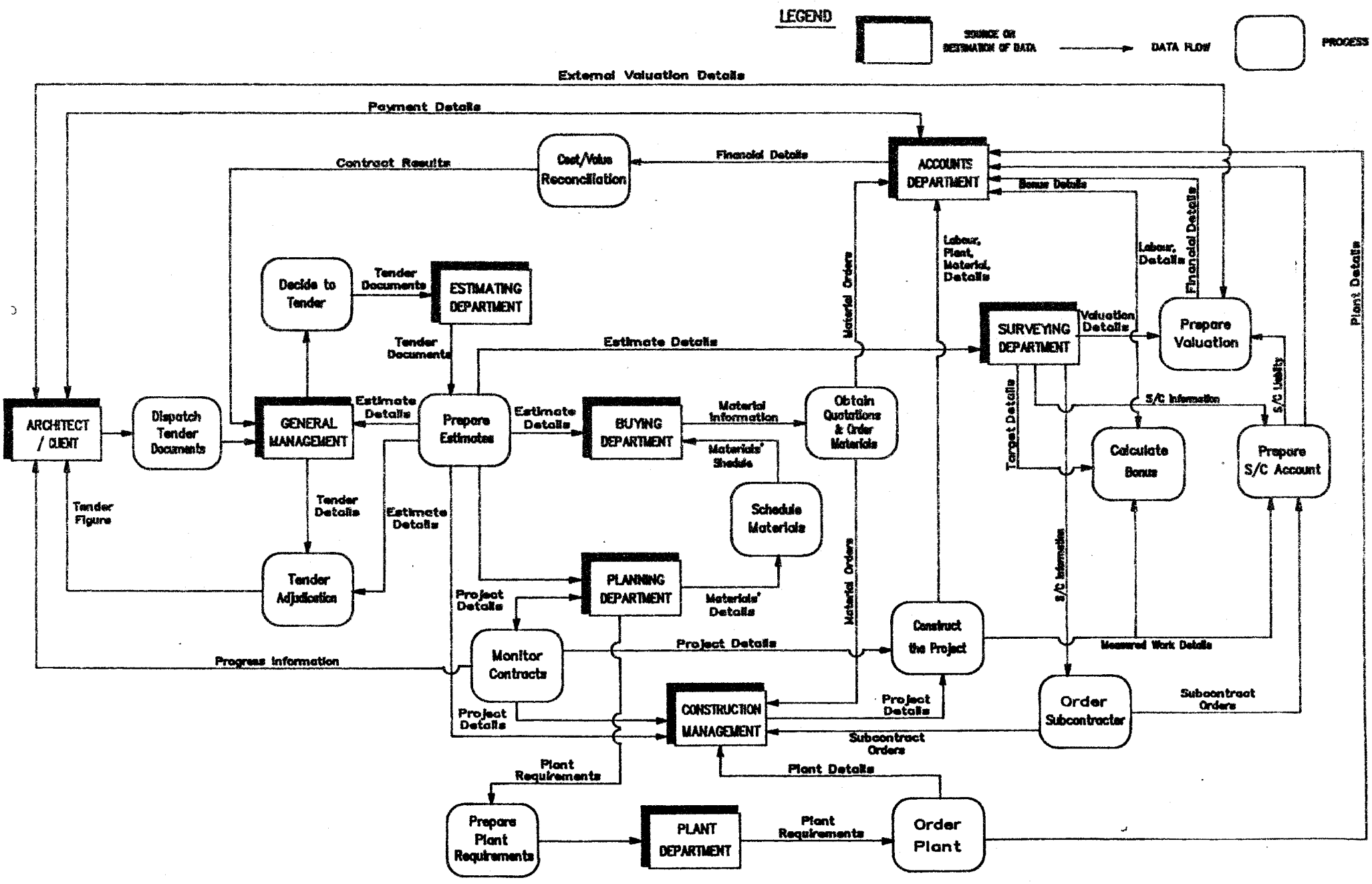

Figure 1. Typical Context Data Flow Diagram

represent a structured specification, leading to the design and eventual implementation of a new system.

SYSTEM DEVELOPMENTS

The design and implementation of a system will be influenced largely by an organisation's operations and, its personnel. The extent of the staff's computer knowledge, and the degree to which the system is going to cause changes to existing practices will need to be addressed, together with the timing requirements of system implementation.

The system design will include both logical and physical design stages based on the previous analysis work. Thus, user requirements and system specification, data inputs and outputs, entity diagrams, normalisation techniques and the creation of file structures and user screens will form important parts of the design process (Senn, 1989; Stephenson and Blaza, 1989).

Following on from this work, the development of small stand-alone applications may be appropriate at departmental level. This approach is more likely to be acceptable to company staff whose knowledge can grow with the development work and are therefore more likely to accept and use a new system. Appropriate staff training at various stages of development will also help with acceptance of a system.

THE INTEGRATED SYSTEM

Whilst initial stand-alone development may be useful in the early stages of development, it is important to realise that these are only part of the integrated system. The identified files within the applications developed at departmental level, will therefore form the basis of the integrated management information system.

An integral part of the system can be the representation of data in the form of an integrated database. The integrated database concept may therefore be appropriate to avoid, data duplication, data redundancy, and the avoidance of outdated departmental data.

A diagrammatic representation of an integrated database is shown in Figure 2. This illustrates the various departments within an organisation that form part of the integrated system, and the relevant data files associated with their operations. Whilst the diagram does indicate duplicated data files within the integrated database, this is for illustrative purposes only. In reality, only one of each file type would be present within the database; accessible by all departments and specific users. The inputs and outputs at departmental level may take several forms and include items as shown in Table 1.

In practical terms, the integrated database approach allows the linking of files via common data fields. Figure 3 illustrates typical links between three data files. Several data files may therefore be used to generate the required information.

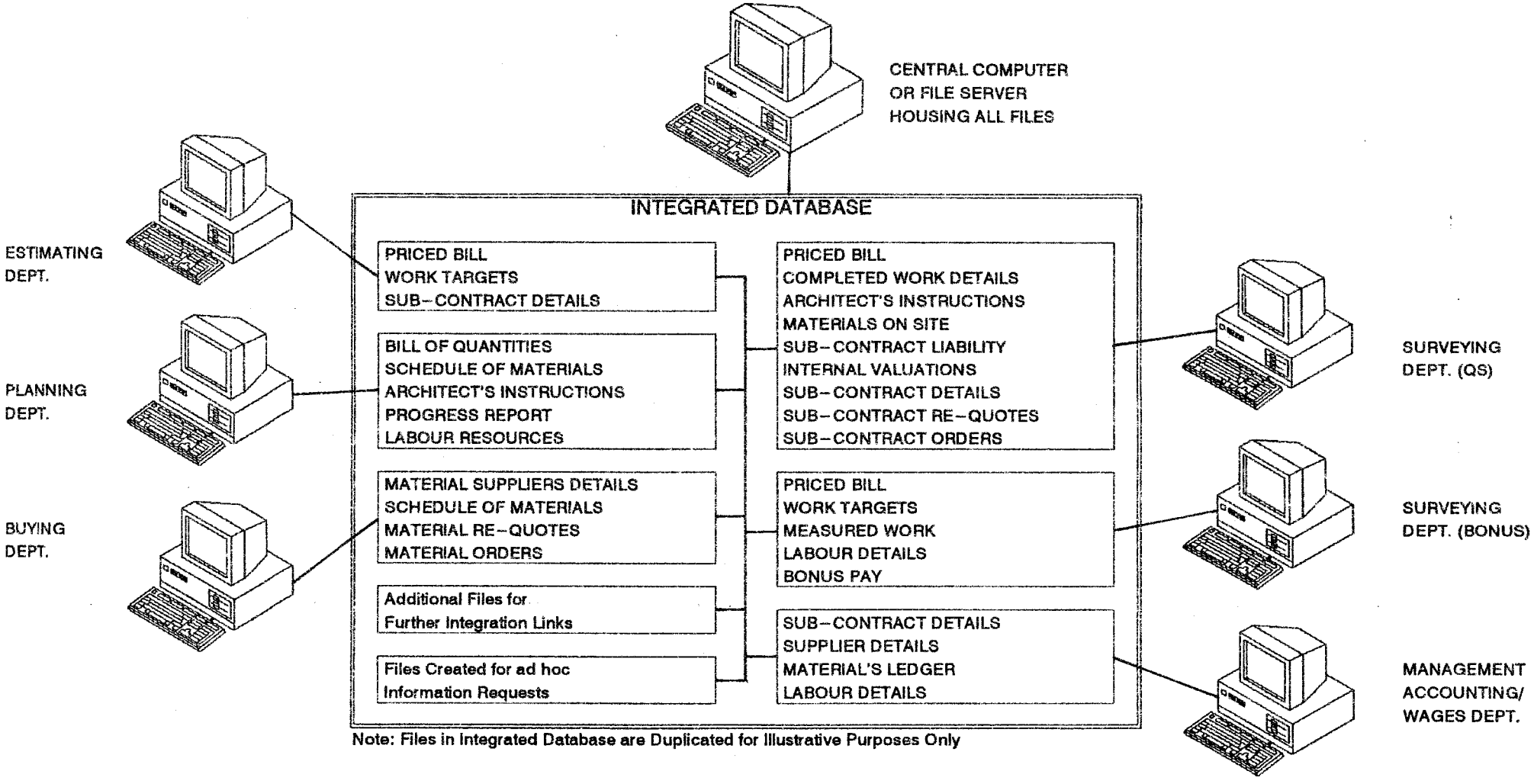

Figure 2 Typical Integrated Database

DEPARTMENT	INPUTS	OUTPUTS
Estimating	Priced Bill of Quantities	Cost Feedback
Planning	Materials' Schedules Labour Resources Progress Details	Progress/Cost Comparisons Resources Monitoring
Buying	Supplier Details Supplier Re–quotes	Material Cost Comparisons
Surveying (QS)	Measured Work Details Architect's Instructions Materials on Site Sub–contract Orders	External Valuations Internal Valuations Sub–contract Payments Cost Comparisons
Surveying (Bonus)	Measured Work Details Work Targets Bonus Details	Bonus Payments
Management Accounting/ Wages	Materials Delivered Details Supplier Details Sub–contract Details	Payments Cost Comparison Reports

Table 1 Typical Input/Output Formats at Departmental Level

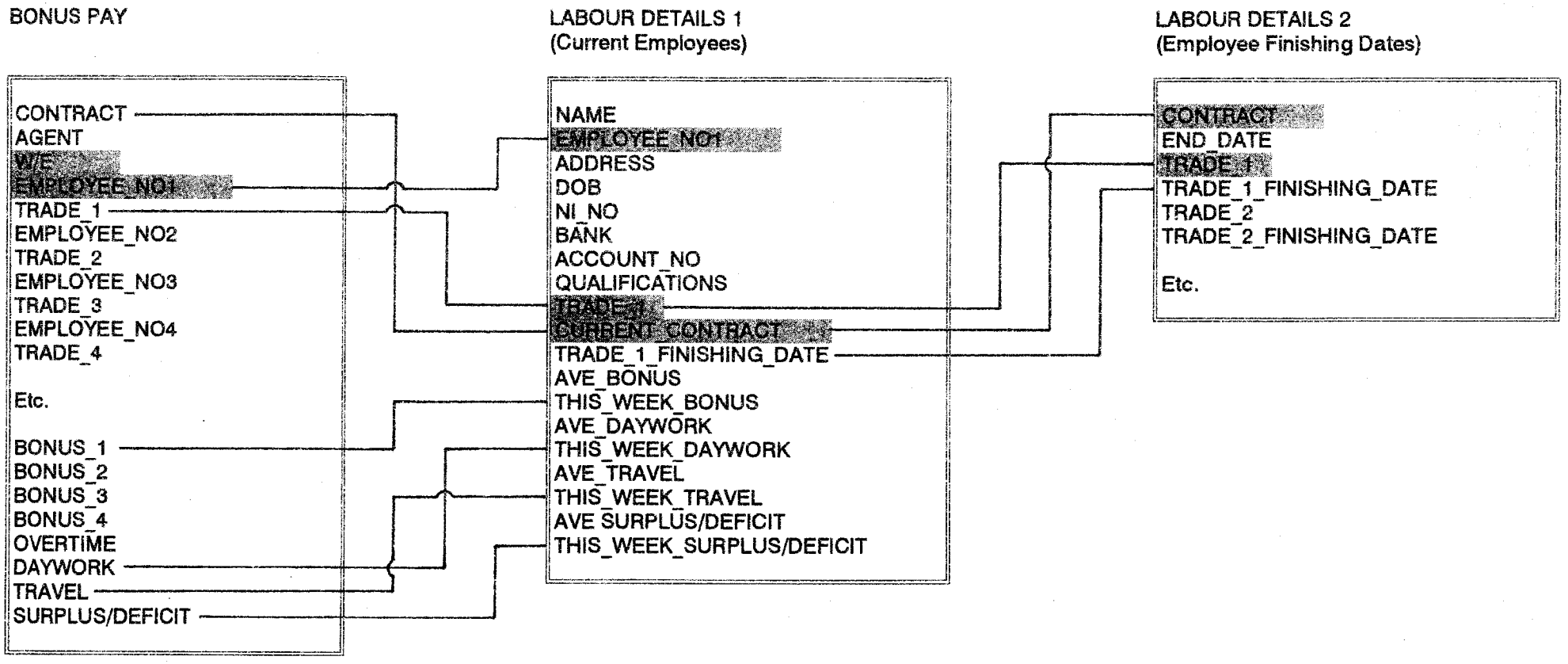

Figure 3 Typical Arrangement for Linking Files Via Common Data Fields

IMPLEMENTING THE INTEGRATED DESIGN

Implementation of a system will largely be depend upon the requirements of information generation. In recent years, database management has played a major role in company systems development and several Database Management Systems (DBMS), together with other software development environments are now available. Such systems also support their own programming language for software development and many are also be suitable for networking purposes. Individual applications can therefore be written for specific users, independent of data storage. The development of additional application programmes is therefore possible, as part of system's development and growth.

The integrated database concept has several advantages in that data needs only to be entered once. Similarly, updating and data maintenance can be carried out centrally. All users therefore have access to the same data within the database. This also results in time savings in data transfer between departments and provides the opportunity for greater report generating facilities. Additional ad hoc file creation may be possible to provide specific report formats for senior management.

MANAGEMENT IMPLICATIONS

Whilst the benefits of such an integrated system assist in data transfer between departments, correct and adequate management of a system is of paramount importance. It is essential that the database, upon which all departments are dependent for their particular information requirements, maintains its integrity and security. The incorporation of adequate maintenance and enhancements to the system to meet the increasing information demands of users is essential. Additionally, there is a need for an information technology manager or database administrator, together with supporting staff. This will provide a backup service for departments and users to ensure that company operations continue to function efficiently.

IMPLEMENTATION PROBLEMS

The development of stand-alone applications and integrated database design form part of the work requirement towards an organisation's integrated system. However, there is also a need to address issues in addition to the technical problems of system development.

One major problem relates to the people within an organisation itself. Much will be dependent on the existing systems and the extent of change requirements resulting from the introduction of information technology. Current methods used in an organisation may have been in place for many years. The introduction of an information system, therefore, can cause organisational and cultural changes in addition to the immediate changes in data processing. Departments within construction organisations are often autonomous and problems can occur in breaking down departmental boundaries with regard to data sharing. The

question of data ownership can emerge and resistance may be experienced concerning the integration of departmental data.

Staff attitudes are therefore extremely influential to a system's success. Certain staff may see immediate benefits and warm to the new technology, whereas other may resist and have a tendency to resort back to previous methods. It is essential therefore, that an organisation is fully committed to the implementation of a new system, and this message must be communicated at all levels within an organisation.

CONCLUSIONS

The development and implementation of information systems in construction organisations involves the consideration of numerous issues in addition to the technicalities of system development. Company philosophy and structure are inherent in computerised system development.

Whilst the integrated systems approach has advantages, this can demands changes in traditional methods of working and may challenge established departmental boundaries. An organisation may therefore have to consider its internal structure in line with an integrated system.

The problems of implementation do not always lie with the technological aspects of system development, but often with the people within an organisation. Whilst the technological issues are important during the design and development stages, they do not always ensure success of a working system. Two complementary programmes may therefore be required. One involving technology and dealing with analysis and design: the other concerning company staff and the management of organisational change.

An integrated system which addresses these issues and which satisfies the organisation's demands, will therefore provide the opportunity for a more efficient and productive organisation.

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