REVERSE PROPAGATION OF DATA FOR BUILDING MANAGEMENT

Reverse propagation of data

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Abstract

Lifetime data for the management of buildings is becoming more feasible and is now expected by more facilities managers. It should be possible to extract the data related to the building fabric and systems from that generated during design and construction. For this to be just what the users require and in the form they require it, depends upon their involvement at an early stage of a project. Reverse propagation can then enable their wishes to influence the data collected so that redundant data is not produced and does not cause confusion. New forms of procurement such as partnering, allow this early involvement; alternatively there must be standards to define the general form of management data. In Denmark the CIS-CAD system defines a simple format being tested on a series of projects. It extracts information needed for statutory authorities and management, and examples are given based on continuing experience of its use. The principles of reverse propagation are discussed and the trend in databases to allow input from both ends of the process. This will eventually allow a more precise and economic definition of the building model and core data needed for management.

Keywords: building management, facilities, model, CAD, reverse propagation

1 Introduction

Like any new discipline, Facilities Management has grown beyond its original requirements for managing buildings more effectively. As the value of property has risen, and the demands of occupants have increased, the need for better management of the space occupied by a business has resulted in a major industry. The field of FM

now requires a wide range of management techniques (Alexander 1997) including:

- Quality management
- Value management
- Risk management
- Environmental management
- Information management
- Project management

This diversity has tended to make FM just another management discipline and to relegate the building fabric to a minor element within the total operation of a business. There is a need for those in construction to focus on building management which regards a building as an organism which is defined at conception and should carry useful data with it throughout its life.

It is perhaps understandable that property owners, acquiring several buildings of different ages, will want to resurvey each of them to capture data needed for management in the form that suits their policy. However, a growing number of new buildings are constructed from data models that contain much of the data needed for management. Until now it has been difficult for the eventual user of a building to specify the content and format of the data needed. But, with new forms of procurement, such as partnering and Design, Build and Operate, the user and owner are more likely to be known when design commences.

Any building project involves a growing body of information, from the client's brief, added to by designers, given as instructions to contractors and, sometimes, data specifically added for maintenance and control of the resulting building. This has led to a one-directional structure adding detail as the process develops and often resulting in an excess of information which may be passed on to building managers in an unsuitable form. The reason for generating excess information is that so often disputes in building result from inadequate, or late, information. With the new spirit of partnering promoted in the UK by the Latham (Latham 1994) and Egan (Egan 1998) reports, a more efficient and effective exchange of data should be possible.

2 New patterns of project data

Information technology, particularly that of databases, has developed from a hierarchical form (1), to a network of relational items, and now to classes of objects sharing and inheriting attributes. The implication is still that data is input from the beginning of a process and extracted at the later stages (2). A more useful approach, involving reverse propagation, would be to think of the necessary data being specified from either end of a process, and being supplied by the most appropriate member of the project team (3). Each member of the team can then extract only the data they need from the building model which they have helped to specify. Fig 1.

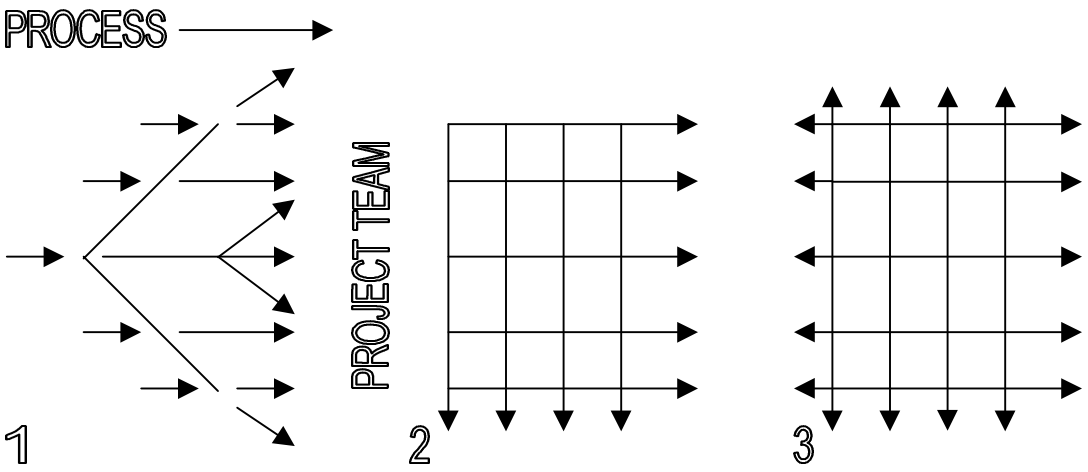

Fig. 1: Development of project data flows towards a reverse propagation network

With reverse propagation, the data needed is specified by the user, and the total data set should not exceed that specified by all those involved in a project at some stage. The client inputs the basic requirement but is advised by the designers what is possible and what additional data is needed. The designers' instructions can meet the specified needs of a pre-appointed contractor, who can add experience from a production model such as that proposed in Model Based Construction Process Management (Laitinen 1998). Product manufacturers and specialist suppliers now contribute more data to a building project and the managers of the building, if involved early, can specify the data they need for operation and maintenance. The result should be the elimination of data that is transferred because one member of the team is ignorant of the needs of others or fearful of not providing enough.

Reverse propagation is carried out in several stages with the data user's requirements being specified first, input of this data by designers and contractors, then delivery of just the data needed when the project is completed. An example might be performance specification where a designer describes the conditions which a product or material has to fulfil, and suppliers will offer their solutions to be selected by the designer or contractor. The customer is given increasing importance in new ways of organising the building process. This should involve the building manager in specifying the needs for management data. The project team then have to respond to this by ensuring that it is included within all the project data and that it can be extracted and delivered on completion of the building. Reverse propagation just reflects the customer's importance in the organisation of building data.

3 Types of data used on a building project

If the types of data on a building project are analysed, they can be classified as:

- General data on building
- Required by statutory authorities
- Specified by the client
- Required for development and analysis of the design
- Required for presenting the design to client, authorities, public, etc
- Instructions to contractors and suppliers
- Instructions for maintaining and managing a building

To these can be added the administrative data needed to establish the relationships and responsibilities of those involved, and the inevitable missing items that no one has specified and which can cause problems at the later stages of a project.

Types of data that are superfluous after completion of construction include: much of the general data on building, some of that required by statutory authorities, design analysis apart from that which might be required in altering the building, presentation material used to inform or impress the client, and instructions to contractors which do not contain information on the materials or components used in the building. Often this data is passed over to building managers when their real needs lie in instructions for maintenance and control of systems in the building.

With traditional contracts there is a general understanding of the data needed by each member of the team and who usually supplies it. In newer forms of procurement these questions, on the data needed and responsibility for its supply, must be redefined. The British Property Federation proposed a form of contract in the UK in the 1980s which defined the roles of design manager and construction manager, and the deliverables which each designer and contractor should provide. It proposed relating payment to receipt of these, whether they were drawings delivered by designers or work packages completed by contractors. But for a few trial projects, this form of contract has been little used in spite of its clear definition of responsibilities.

4 The Danish CIS-CAD documentation

An example of reverse propagation is a Danish building ministry sponsored project started in 1994 to define the data needed by various users to manage and administer completed buildings. It was carried out by the BPS centret with representatives of the ministry and advised by a project group of experienced architects, engineers and contractors. It was revised under a project led by Ejvind Alf Jensen and published as a set of guidelines in 1997 (Boligministeriet 97). It has been tried on several housing projects, some of which have now been completed, and the experience of the data management published. CIS-CAD regards the building model, used in the design and construction process, as a resource for feeding three different types of database used during the building's lifetime (Fig 2).

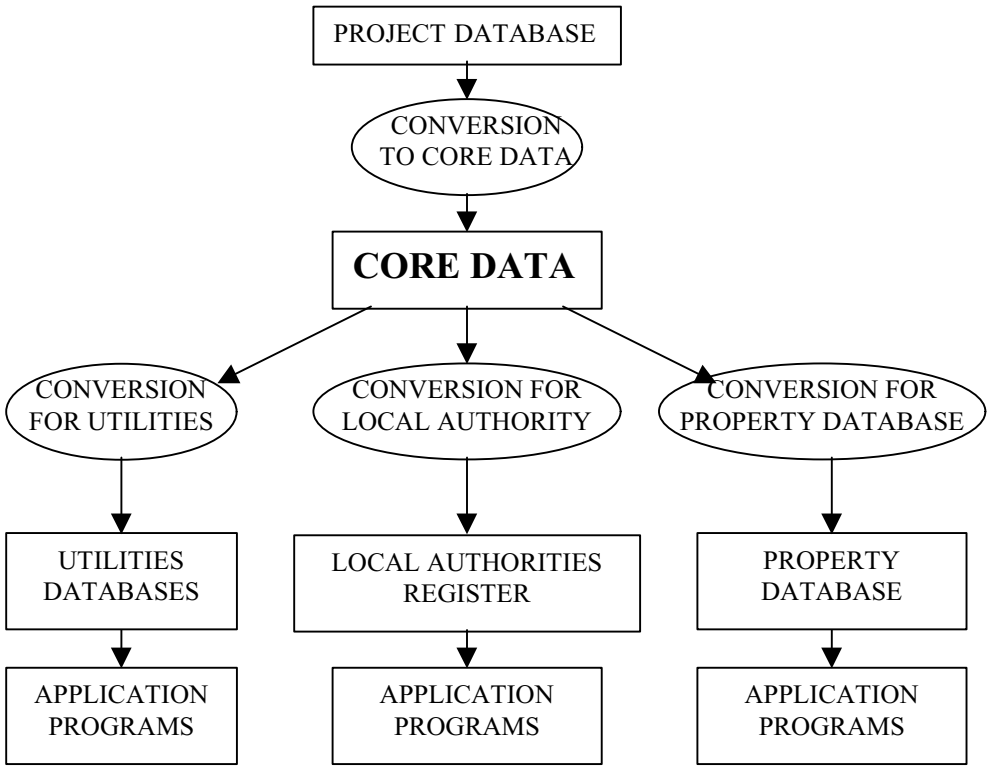

Fig. 2: Extraction of data used over the lifetime of a building - CIS-CAD

The management core data, extracted from whatever form the design and construction data takes, is defined by the needs of three main types of user:

- Utilities - connections to gas, water, electricity, drainage, and site plans.
- Public authorities for property taxes, floor areas, standards addresses, etc
- Building owners and managers for management and maintenance

Some of this data is not very demanding but needs to be in conventional form. The location of connections to the main services, and the calculation of floor areas, must be given in precisely the form specified by the relevant authorities. Building management data is more substantial but, where a building is commissioned by the organisation which will manage it, and this is relatively common in Denmark, the requirements for floor plans, details of equipment, maintenance schedules, etc, can be specified for extraction from the design data.

CIS-CAD is realistic about models being defined in drawings, specifications and quantities documents for some time yet, but requires the elements of building to be regarded as objects. These are not necessarily objects in object-oriented systems or Industry Foundation Class terms, but commonly coded elements which can be linked by their codes. These codes are based on SfB Table 1 elements but add details required by the authorities using the data. The system has yet to be widely deployed but a number of trial projects have been carried out and it is strongly promoted by the building ministry.

Experience has shown that building owners typically require data at one of two

levels: just the site plan with administrative data, or a more complex model of the building. At present few buildings in Denmark are designed using objects, although the IT barometer survey showed a move towards more sophisticated CAD data structures (Howard 1998). The Point add-on to Autocad is widely used and it can provide object-based building models for CIS-CAD although these are not yet based on the Industry Foundation Classes.

5 An example of CIS-CAD on a project

In 1996 a housing project in Naestved was built to a data structure based on CIS-CAD used by the architects and engineers, but the Kommune which managed the buildings did not then have sufficient CAD facilities to take over the graphic data. A more complete example, which is still being built, is at Aalborg University where Poul Sorgenfri Ottosen of the technical administration is leading some research into management of buildings with advanced data structures. This is the second stage of sector 8 and is again being designed by the consultants, Dall & Lindhartsen architects and Carl Bro, engineers, using objects organised by SfB Table 1. (Fig 3)

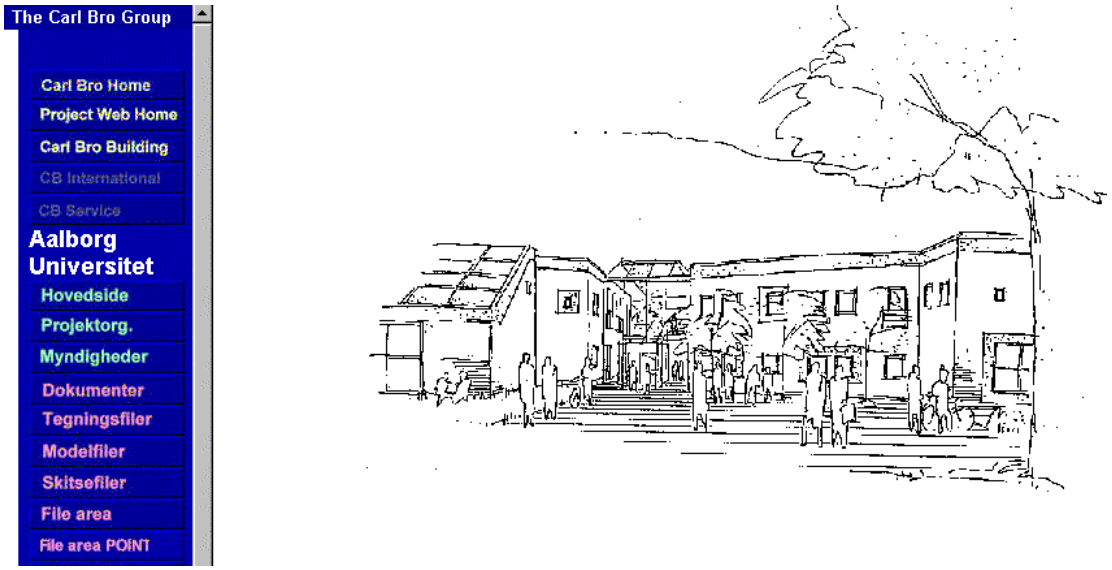

Fig. 3: Image from Project Web site of new humanities building at Aalborg University

The core data from these objects will be taken over by the technical administration and used to manage the building based on CIS-CAD. However CIS-CAD will need to change its current structure to be fully compliant with the SfB codes which have been used by the designers. A detailed description of this important project is given in two reports from Aalborg University (Aalborg 96 and 98). Poul Sorgenfri Ottosen will be describing the design process and its relation to the Industry Foundation Classes in another paper. The Building Ministry is supporting the work on CIS-CAD and helping to ensure that the experience of using it is widely known. This

project is also of interest because the documents are held on a Web site accessible to the firms involved, using a system called Project Web developed by Carl Bro A/S. Once the data is held in a form which continues throughout the duration of a project and all those, including clients and managers have access to it from the beginning, then reverse propagation of the needs of users becomes possible.

6 Use of FM systems in Denmark

One potential problem with making management data available to client organisations is that they may be using different facilities management systems to handle the data. If the data structures and formats of their systems are known at the beginning of the project, it may be possible to provide data in the right form, but it would be preferable to have a common interchange format for FM systems, better than the 2D DXF or DWG formats from Autocad. A study of the use of facilities management software systems carried out by CIS-CAD (Boligministeriet 98) shows this diversity. Although the use of such systems is at an early stage, the market is shared by a number of different systems. These will each have their own data structure although four use Autocad for their graphic data and two others use the SQL database standard.

SYSTEM NAME	ARCH-IBUS	AUTO FM	POINT FM	CARE-TAKER	DRIFT-CHEFEN	F M A	FRON-TINUS	TIPS
DANISH OWNER/ DISTRIB-UTER	Dana Data	Berend-sen Com-ponents	CAD Point	COWI	KeyCon	Scan CAD/ Aalborg Univ.	Bascon	NNR
ALL USERS	>50000	Ca 500	100	Ca 400	102	20	50	100
DENMARK	Ca 20	15	10	Ca 300	52	20	50	1
MAIN MODULES	Space Autocad Furniture Telecom Operatns Lease	Areas Location Personel Telecom Register Barcodes	Areas Core-data Property and Building	Coredata Mainte-nance Budgets Contracts	Services Energy Photos	Areas Mainte-nance Purchase Budget	Standard system with modules	Areas Energy Fire Services Mainten-ance
DATA ST-RUCTURE	Object oriented	Object oriented	Current standard s	Hier-archical	Object oriented	Object oriented	Hier-archical	Relational database
LINKED SYSTEMS	Many Eg SAP	Special interface	Via SQL	Sybase SQL	Yes	Excel	Windows programs	
LINKED GRAPHICS	Autocad	Autocad Intellicad	Autocad	Document manager	Can read all formats	Autocad	Links to drawing	IBM AE Series

Fig. 4: Table with some properties of FM systems available in Denmark

7 The trend towards reverse propagation

Reverse propagation of data requires all those contributing to, or using, it to be involved from an early stage. All links into the data model should be two way with early input of their requirements by users of the data. Where some partners are unknown, conventions or standards, where they exist, must be relied upon. Model sets of data for building management would be a great advantage since so few building occupants are known from the beginning of a project and they may change throughout the life of the building. Most countries already have standard definitions of construction data, for example the Coordinated Project Information system in the UK (CPI 1987), but these are based upon traditional forms of document and elements within them, such as the Standard Method of Measurement for building quantities in CPI, are more detailed than the user of the data requires.

With partnering arrangements in place, an early task in any project should be for the team to discuss data requirements and formats. The standards on CAD layers, both international (ISO 13567, 1997) and British (BS 1192 Part5, 1998), define how to structure CAD data, but the British standard also gives management guidelines on the items that need to be agreed with regard to roles and responsibilities. This is the opportunity to ensure that the data transferred between the partners is not excessive. In Denmark, the PPB housing consortia carrying out a series of experimental, typically prefabricated, housing projects, refer to their relationships as 'vertical integration' which is similar to partnering. When the benefits of this have been assessed by various research projects at DTU, it may demonstrate the benefits of continuous relationships on a series of projects.

It is only these long term links which allow the end users of data to be involved from the beginning and to specify the type and form of data they require. More such projects will allow the benefits of reverse propagation to be clearly established and for redundant information to be kept to the minimum. There is valuable experience being gained in Denmark of the use of relatively simple systems for transferring data from building design to management. This does require the needs of building managers to be known and, when their general or specific requirements are defined at an early stage, the benefits of reverse propagation can be attained.

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