

25 Years' Development of  
Computerised Contract Documentation  
- and the Future

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ABSTRACT

The developments of the past 25 years are reviewed, beginning with the preliminary studies and the purchase of a now museum-piece computer, through changes of hardware and significant improvements in the services provided, to the use of main-frame computers linked with micro-computers and their direct interaction with computer-aided drafting.

The current situation is described, showing how the needs of the construction economist/quantity surveyor/estimator (reflecting Building Owners' contemporary problems) are satisfied by specialised sub-systems. All aspects of pre- and post-contract documentation and ancillary applications are covered, mentioning such common facilities as word-processing only when used directly.

There is a discourse on the future, particularly of the aims to provide completely automated estimates and contract documents and to generate expert (knowledge-based) systems as a precursor to fifth-generation computers.

Within each area the problems, the methods of solving them and, except in conjectures, the conclusions reached or the measures of success achieved are presented.

Le Progrès des 25 dernières années  
dans le Domaine de la Documentation Contractuelle  
d'ordinateurs - et l'Avenir

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ABSTRACT

Le progrès des 25 dernières années est visé, d'abord dans l'étude préliminaire de l'acquisition d'ordinateur démodé, ensuite dans l'étude des modifications du matériel et les améliorations importantes de services fournis, et finalement dans l'étude de "Mainframe" ordinateurs liés à des micro-ordinateurs et leur inter-réaction directe avec la rédaction faite par des ordinateurs.

La situation actuelle est décrite, démontrant comment les sous-systèmes spécialisés satisfassent aux besoins de l'expert de l'économie de la construction/"quantity surveyor"/deviseur (à ce qui concerne les problèmes contemporains de Propriétaires d'Immobilier). Il est fait mention de toute question portant sur la documentation contractuelle antérieure et postérieure aussi que des applications auxiliaires, visant des facilités habituelles telle que traitement de texte uniquement lorsqu'elle est utilisée directement.

Il existe un discours sur l'avenir, surtout en ce qui concerne la fourniture de devis et documentation contractuelle totalement automatisée et de donner lieu à des systèmes approfondis (basés sur la connaissance) en tout que d'ordinateurs de la cinquième génération.

A chaque titre sont présentes les problèmes, les méthodes pour les résoudre et, sauf lorsqu'il s'agit d'hypothèses, les conclusions auxquels ils donnent lieu ou les niveaux de succès atteints.

## INTRODUCTION

Before embarking on this review it is of importance to emphasise the difference between North America and Great Britain in the understanding of the term "quantity surveyor".

The North American perception is of a lowly measurer or "quantity lifter" who provides quantitative information to assist the contractor's estimator; the term in normal British parlance is of a highly qualified professional, university trained, who is the Building Owner's financial adviser at all stages of a project, from inception and preliminary feasibility to financial settlement of contractors' accounts. It is in this latter context that the terms "quantity surveyor" and "quantity surveying" are used in this paper.

1962 - 1964

### PRELIMINARY STUDIES : IMPLEMENTATION

Until the early 1960's contract documentation had all been laboriously produced by manual methods, these being, sequentially, the "taking off" of quantities from architects' and engineers' drawings, the calculation of resulting gross quantities related to items of work described in an accepted and predetermined way and the writing and subsequent typing of a bill of quantities on which tendering contractors could submit their bids. Monk Dunstone Associates pioneered computerisation to replace this outmoded process.

The salient criteria of current relevance involved in our preliminary studies and the decision to buy the computer were :

- 1 - the equipment had to be capable of handling bills of quantities and all other building industry applications
- 2 - it had to be reliable and thoroughly proven
- 3 - servicing had not to involve resident engineering staff
- 4 - the machine and its associated equipment had to be compact
- 5 - the capital cost had to be within reasonable limits

The importance of 3 and 4 have diminished with the micro-chip; 5 is still very important. Research teams worked on the financial and administrative problems and on the writing of programs and the compilation of Standard Libraries of Descriptions.

The detailed aims of the project encompassed :

1 - the elimination of all manual calculation and the production of finished (not draft) bills of quantities faster and more accurately.

2 - the production of Standard Libraries of Descriptions to cover, as far as practicable, the whole of the building and civil engineering industries and the storage, in phrased form, of a vast number of such descriptions.

3 - the easy retrieval of data for the following :

3.1 - production of elemental and operational bills of quantities

3.2 - feasibility and overall checks of gross quantities

3.3 - network analysis of projects

3.4 - analysis of labour and material constants

3.5 - interim valuations and final accounts

3.6 - cost monitoring of projects in progress

3.7 - cost planning and approximate estimating using computer-generated quantities and computer-held prices and the adjustment and updating of these prices

3.8 - conversion of data into foreign currencies and storage of descriptions in other languages

An Elliott Brothers 803 computer, consisting of a main-memory of 8192 39-bit words, four magnetic tape units each with a capacity of 256K words and paper tape input/output facilities, was purchased outright in 1962. The whole project was fully operational in mid 1964 - the first job processed was a \$10 million (1986 value) university residential building. The systems were developed and improved (1964 - 1980) and ran successively on IBM 360, 370 and 4300 series machines, processing documents for many thousands of projects.

The main-frame system described above has now been replicated and enhanced using hard disk multi-user micro-computers (typically the Molecular series of machines). The networking capability of these machines permits a number of "takers off" to enter dimensions directly and simultaneously and to select the appropriate description from the, now, screen-based Standard Library of Descriptions, accepting or modifying the descriptions thus compiled and then transferring them to the project data-file.

The disciplines and logic built into the 1964 main-frame system have held up well when transferred to the micro system, justifying, for the second time, the painstaking feasibility studies and comprehensive analytical approach to structured Libraries which was adopted initially.

Apart from the obvious commercial advantages, a significant concomitant of the whole process of computerisation has been its effects on staff. It has produced an exciting and attractive sense of corporate focus whilst, at the same time, aiding management in controlling and standardising the quality and content of the documentation being produced.

Particular attention has been paid to mechanical and electrical services and specialist programs have been prepared for the automatic calculation (for both estimating and tender documentation purposes) of fittings, insulation, overcladding, fixings and supports, etc.

To impart relevant information to tendering contractors in both electronic and written form has always been seen as of key importance. Despite twenty year's reluctance, tenderers are at last beginning to exploit the benefits of communication with consultants' computers.

The system has been successfully linked, operationally, to computer-aided drafting systems (the first major client being the Mobil Oil Company). Using one of the standard facilities of the system (the "Cross Box" technique), comprehensive files of descriptions and relevant measurements corresponding to the "drawn objects" held within the CAD database are compiled and stored within the system. Selection of the "drawn object" by the designer automatically triggers the appropriate "cross box" which is then transferred to the project data-file.

This concludes the brief description of the development of the core tender documentation (bills of quantities) system.

#### SUB-SYSTEMS

The modern Building Owner requires much more from his quantity surveyor than the production of tender and contract documentation. A series of sub-systems has been developed around the core system to satisfy these pre- and post-contract needs.

Project feasibility programs with facilities to change funding rates, land costs, construction costs, inflation projections, etc. have been developed to assist the Building Owner in deciding on his project priorities at the earliest possible stage. An adjunct to these programs is a series of cash flow prediction programs permitting the selection of a number of expenditure curves for different building types (derived statistically from historical data) which can then be subjected to "what if" interrogation with such variables as construction time, inflation rate, etc.

Large cost databanks have been assembled from in-house sources (elemental re-analysis of contractors' bids) and externally published information which can then be manipulated to suit the requirements of the project currently under consideration

Sophisticated estimating systems have been developed based on the allocation of resource levels (labour, materials, plant) to the Standard Library descriptions for commonly occurring items of work. This enables fully resourced estimates (increasingly detailed as the project information develops) to be prepared providing much more accuracy than was possible by the more traditional "unit rate" approach used by many UK quantity surveyors. The information on resources thus generated provides not only normal pricing information (labour hours by trade, volumes of materials, etc) but also transportation weights, volumes, etc which are so important on geographically remote projects.

By holding the successful contractor's prices against the items in the bills of quantities (one of the Contract Documents), re-analysed operationally if appropriate, a post-contract database is created which forms the base for interim valuations (extracted and produced automatically) and the evaluation of variations (change orders). The amalgamation of the financial effects of variations with the post-contract database provides immediate cost status reports for the Building Owner and permits the swift production of the project final account for agreement by the contractor.

Cash flow programs, similar to those described earlier, permit the financial effects of corrective changes to construction programmes to be examined before instructions are given or additional resources employed.

There is still considerable scope for the development of further post-contract applications especially if compatibility can be achieved between the computer systems used by the architect, engineer, quantity surveyor and contractor.

#### THE FUTURE

We see future developments in the production of contract documentation being directly related to the compatibility and eventual integration of the systems used by all members of the project team. To harness the scheduling capability of computer-aided drafting systems and their growing ability to "quantify" in the traditional sense are key elements in this process.

Knowledge-based systems for construction cost estimating are in their infancy, simplistically dealing with a discrete repertoire of components such as drainage systems.

Whilst the detail implicit in working with fifth-generation machines is not yet clear, we are happy that the concepts we have evolved with the earlier generations of data processing equipment will prove transportable. In other words, we see the whole process as a natural progression. The work that Monk Dunstone Associates has carried out in the field of automatic measurement, referred to briefly above in the context of mechanical and electrical services, convinces us that a combination of measurement and specification systems generated partially by CAD and partially by automatic means is the likely way forward.

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