

Production Orientated Tendering: A résumé and re-examination for the early eighties of the issues involved

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The Need for a Résumé

Judging from the questions still frequently raised with the author, most quantity surveyors have heard of operational bills¹, the initial documentation from which production orientated bills were devised. But, it can still be questioned if the objectives of this type of bill and the limited meaning of its title are clearly understood. Many surveyors in spite of knowledge of preliminary types of bills seem unaware of all the true facts. For example, it is wrongly believed the document is based on the premise of the quantity surveyor instructing the contractor the order for executing the works in the post-tender period. A distorted image of the documentation exists too, e.g. many surveyors regard the operational bill as being a thick document. When the last version of experimental operationally biased bill was produced it was much smaller than a traditional bill of quantities for a similar project.

This paper re-states the basic philosophy behind the production orientated tendering documentation frequently referred to as "operational bills of quantities". The final title when the then BRS ceased research work in this field, circa 1968, was "production orientated bills". It brings the case for a production orientated bill up to date by explaining how some form of documentation having this nature is especially needed today to meet the growing need for communicating waste levels stemming from dictates of building design and accounting for materials.

Background to the President Principles of Bills of Quantities

The principal means of communication, in the construction industry, which have remained unchanged since they were established early in the Nineteenth Century are the drawings, bills of quantities and the specifications. However, the industry in the early 1980's is considerably different from the one which operated when the present tendering procedures were evolved.

The building industry is unique from other industries because the process of design is isolated from the subsequent production operations. For any industry it is necessary that the designer should be aware of financial consequences of his design decisions but in construction where the design and construction are usually undertaken by separate organisations it is most important that there are adequate formal checks and communications in realistic terms between the two functions.

In the best interest of the investor today it is more important than ever before, due to the present economically unstable building market, that the communications provide for the most efficient and forceful management control over the project which the client is financing. The principal form of communication in calculating and controlling financial resources commences with some form of statement of the designers' requirements, i.e. a specification and drawings.

Several systems of measurement and methods of "taking off" quantities have, over the years, been used but from circa 1909² they were standardised by the publication of formal methods of measurement based on the same principles to give uniformity. In broad terms the conventions remain unchanged and are in active use seventy years later, although in a more comprehensive form as the Standard Method of Measurement for Building Works.

The principles on which measurements are based have received little criticism and those people who have made observations concentrated their points on the lack of standardisation (notably Cross, circa 1905, who spoke much and wrote little). The only known recorded comments concerning the principles of measuring conventions before 1960 were made by Mr J. Sumner-Smith, who, circa 1920, considered that bills of quantities for housing should be scientific³. Mr Sumner-Smith also wanted labour to be separated from materials but he did not advocate valuing labour, plant and overheads in any new form. He wrote, "materials should be presented in buying units".

Failure to have any change in the principles of

measurement is possibly due to two reasons:

- (i) The measuring conventions on which "quantities" are based work tolerably well.
- (ii) The absence until recently of any critique concerning quantities which would stimulate discussion and questioning.

A study undertaken in 1959⁴ indicated that although bills of quantities were not then used in Europe the process of obtaining a tender there used similar data and moreover, all communications for post-tender management, e.g. planning, etc., passed through the estimating stages.

Controlling Financial Resources at the Design Stage

A fundamental requirement for any industry is a system of working which affords optimum communications, management and control. The best possible return on the resources employed can only be obtained by the optimisation of these three facets of business, and in a society experiencing a rapid change in its technologies it is imperative that the working procedures should be under continuous review.

The controlling factor for the specification of resources is what the investor can afford to pay. But the information now in use fails because it is not feasible at the conception of the design to accurately predict the optimum economic solution and the final financial liabilities of the client without a stable prediction of the builders' resources.

The cost of labour, plant and overheads in building are expended in terms of time but are communicated in the technical accountancy and resource control processes in terms related to the physical measure of the finished work. Hence, when attempts are made by designers to consider the building process in their design by minimising the waste level of materials and the labour and plant and the time required for a piece of work, the relevant data cannot be communicated to those who are bidding so that the tenders may reflect any savings in building costs.

An international study group identified that the techno-economic problems which need attention to reduce building costs are all interrelated and comprise a variety of factors which are common throughout the market. In order to reduce costs first a knowledge is required of them⁵.

The principal problems fall under two headings:

1. "Cost" to the investor — the cost to the investor of a project is one of the greatest

constraints on demands, e.g. costly housing can only provide accommodation for the few people who can afford it, while cheaper housing can provide a shelter for many people. Hence any reduction of building costs achieved by improving design through better communications and achieving greater efficiency on building sites has potential benefits to society.

2. The organisation of demand for the products of the building industry and the present organisation of the building industry itself requires technical appraisal. This is particularly noted when the incompatibility between the estimated "cost" and the production cost is considered. Facts are distorted within the industry because they cannot be examined in the light of true costing and the market remains obscured by having no clearly expressed differentials between efficient and inefficient builders. This is a factor which can also inhibit the introduction of new techniques.

The difficulty of relating prices to design has been particularly overcome by "design cost planning", but these pre-tender preliminary estimates are solely based on historic prices, and are undertaken without any consideration of the site production process and costs. It is a subject to debate whether they have improved design to give better value for money. Distortions can arise when market prices are used as the data base for financial resource control because they can reflect set standards but not fluctuating building costs. In an inflationary market "cost limits" which are fixed for a period can lower the standards of buildings if tenders are accepted which only comply with these limits.

Hence it can be strongly argued that buildings which are cheaper to produce than other similar archetypes may be priced more than their true rating, while those which are more costly, conversely could be underpriced because market pricing is insensitive to the cost of producing each building on site.

Broadly speaking, prices reflect the value of materials used and are not sensitive to the complexities of construction, or the usage of labour and plant. Production costs vary considerably but feedback in a form for tactical use as a guide to site performance is generally ignored in present European practice. However, these "costs" can often be considerably less than the market prices when an alternative but more costly material is used.

It has been demonstrated during studies at BRE that the interruption of building operations can waste considerable time and cause delays. Evidence has been collected to show that on average a third of the time spent on construction sites is often waiting around for other trades. If this potential cost could be wholly or partly eliminated by considering the problem at the design stage savings could be made in the cost to the client.

Ideally any advantages from non-complex designs should be reflected in prices. The merits of new, useful and simple to handle and fix materials, should not be neglected because the present methodology is insensitive to their real cost implications. The investor should have the advantages of modern industrial efficiency incorporated in the "price" and waste-prone designs improved. This can most effectively be achieved by considering production problems of building at the design stage.

Estimating and Pricing Variations for Building Works

During estimating it is essential that consideration is given to the manner in which the design dictates how a building has to be erected, particularly, the type and method of construction. If at a tactical working level the decision making at the design stage ideally had considered the process of construction with the simplification on site operations, the estimator should also be able to clearly see how these would affect the predicted costs to his company.

Site works fall into well-defined tasks which can be tackled by a man or gangs of men without interruption or attendance from other men or gangs. Production costs can vary with the type of labour and plant necessary to undertake the tasks and particularly if interruptions of one trade with other trades are considered. These facts could be reflected by savings in the market rendered price if the relationship were established and quantified.

Prices inserted in bills of quantities are based on principles which ignore the realistic cost of labour, plant and overheads. Moreover the usage of bills is restricted to tendering and technical accounting although much of the data could have considerable value for the Site Manager during building operations. These are major indictments of the principles on which bills of quantities are at present based.

Thus the concept of prices continues to prevent realistic "cost" estimates, the first stage of tendering before any management adjustments are made to turn their data into a bid. Ideally estimated costs for labour and plant should be based on past performance considering all the complexities concerning the use of these resources in constructing the project under tender. Moreover the calculation of overheads and all the facets relating to the complete jobs and sets of operations, like excavations requiring the use on site of certain plant for a specified time, should be seen on a duration basis.

When bills of quantities were evolved the industry was predominantly a simple trade process. Today, the process is highly complex with varieties of plant, labour and materials, being used. Hence the effective management of all resources, particularly the optimum use of labour and plant, considerably influences the final cost of the project and the financial success or failure of a building contract.

When, considering the settlement of final accounts, apart from the materials used, all the costs can only be realistically valued in terms of time. Rates (even analogous) derived from bills of quantities have a data base related to the physical measurement of finished work, i.e. materials in place. Hence, the physical process of construction is considerably ignored because the practice of building works can only be realistically seen as "days" of overheads, "hours" of men and a series of operations or work pieces, each of which ideally should be inter-related.

Further, while the use of quantities may adequately determine the final "cost" of the building to the investor and still are used with little exception throughout the world for this purpose, they have little value to builders in reconciling their own costs particularly at a micro level, the most important aspect of

management control in any production system. The fair assessment of labour output could be achieved by collecting costs in terms of their expenditure, i.e. time — seen as production units or operations.

Since the majority of the contractor's costs do not vary in proportion to the quantity of work measured, many of the adjustments made at the time of settling variations are unrealistic. The only means, open to contractors' surveyors under the present contractual procedures, is for the analogous prices to be considered related to the bill of quantities' rate and then *ex gratia* claims submitted for the other monies the contractor contends are due. This is a highly unsatisfactory procedure because it is insensitive to the actual events which happen and it has long been contended, in spite of such words in the form of contract as "fair", that payment for variations is not only unrealistic but often unreal to the actual costs incurred by the contractor. Moreover, variations often increase the production costs by the disturbance they cause to inter-related operations, yet the relevant quantities and unit rates used to adjust the variation could result in savings for the same event. This point cannot be adequately communicated to the designer when presenting claims because of the insensitivity of "prices" to this type of problem.

Development of Alternative Tendering Documentation

Apart from the postulations of Mr Sumner-Smith, studies at the then BRS, circa 1960-61 are the first known work to challenge the philosophy of "quantities". The research programme which led to production orientated tendering originated from two lines in earlier BRS studies, one involving site costs, the other site management.

The philosophy postulated in 1960 by Stewart Forbes and the author was a duration based feedback system which could be adopted as a base for estimating data, similar to the methodology used by engineers for planning building works during the post tender stages. The author undertook research in 1960 to find if such hypothesis could meet the demands of contractual documentation. This philosophy rejected the "finished work" concept as unrealistic and suggested greater emphasis was to be placed on the role of drawings and planning techniques to arrive at the estimated cost from which the tender price, based on further consideration of the market trends, would be developed.

To demonstrate this new philosophy in practical terms a new form of documentation was devised — "The Operational Bill".

Later when transitional forms of documentation were found to be necessary to implement this methodology in practice, they were renamed Production Biased Bills and the term Operational Bill was solely retained to identify the optimum solution. Several formats of transitional documentation were proposed to enable the evolution from traditional quantities to the operational bill.

While variations using this type of documentation would have been drastically reduced, due to greater attention to details in the design before the bills were prepared in every case, adjustments of measurements would

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usually have been necessary for the works below ground. Although the BRS studies, circa 1962, successfully tried a depth/perimeter basis for adjusting the measurements of site works and recommended day works to give a true direct expenditure for other variations which arose, this approach was never considered as a satisfactory solution. Quantity surveyors saw the absence of a unit rate (and the analogous rate in final accounts) as a major stumbling block to the application of documentation having an operational nature.

However, from the experiments the problem was seen from another angle, the need to measure and realistically value too, the disturbance or indirect costs of variations. Since circa 1970 further philosophy has been postulated from the private research work of the author to settle the variation problem. The opportunity has not yet arisen to test this method under practical conditions.

While production orientated tendering may cover several types of format particularly during the transition stage, all have the following characteristics.

1. In transitional bills, labour is segregated from materials and priced using the conventional labour data base, i.e. based on norms. The feed-back obtained may be reconciled by relating it to an amalgam of bill items which comprise the operation. In the more advanced type of bill labour is priced on a duration for the whole operation to which feed-back is directly reconcilable.
2. In all forms of bills, materials are presented in purchasing terms allocated to the operations and if necessary, locations.
3. Data for pricing plant and overheads are presented in the final section of the bill which is the most appropriate place for its estimation. In the transitional form the precedence diagram is used to calculate a realistic but "outline" time plan of the job using a critical path basis. In the optimum form this is also done but with the labour priced in the site works on the "gang size" basis, the group can then be also adjusted at this stage to ensure a continuance of working of men and plant as far as practical at the break-points between operations. The estimated costing for the operations covered are revised as may be necessary at this stage too.
 - a) Plant is calculated on a duration basis related to the relevant operations as part of the overall work plan of the job.
 - b) Overheads are also related to the outline planning assessment of the time the contract will take which is based on a precedence diagram.
4. A set of drawings giving full particulars of the work are included as part of the document and detailed sketches for joinery and other specialist work are printed as face pages within it. Ideally these drawings could be operational too.
5. Full details are given of any specialist sub-contractors to be employed including the time required for the operations.

Current Appreciation of Production Orientated Bills

From discussions with many quantity surveyors much adverse criticism is still aimed at the objectives of this type of documentation and the

philosophy upon which it is based. Many members of the industry still do not appreciate that the use of precedence diagrams is the means to save contractors analysing the drawings to find the constraints and likely "break points" in operations.

Quite wrongly this "operational pre-planning" is seen as a dictate on the contractor while in reality it is identifying dictates from the designer.

Although now still an open question, it is believed many surveyors feel defining operations is beyond their present training but surveyors who have willingly prepared the precedence diagrams have found their inherent analytical skills as quantity surveyors ideal for this task. Moreover, the precedence diagram has a potentially wider use and could be the basis of assessing the disruptions between operations in realistic terms. This could be developed to identify the root of true cost claims for interruptions which are germane when settling final accounts.

Some surveyors who have been critics of this approach in the past have during recent years changed their minds and concurred this is the correct philosophy for technical accounting but do not agree with the author on how this philosophy should be introduced or used in practice. One professor has come to similar conclusions after studying operational planning, but feels the BRS proposals failed because they did not respect the pattern of responsibilities for contracting using bills of quantities.

The duration data base seems unrealistic to many surveyors and they cannot appreciate that bills of quantities do not provide a suitable base for realistic contractors costing and feel that duration prices will leave "loop holes" in the analogous adjustments so frequently necessary for all accounts. Moreover, many independent quantity surveyors say the present method of settling variations reflects a "fair" reimbursement for builders even when the nature of the work is similar but the circumstances have considerably changed. Others strongly feel documentation should not be postulated for ordering materials for which they must guarantee the data.

Résumé of Developments

Despite considerable application effort, during which the author gave over two hundred lectures, production orientated tendering has not been applied to any measurable extent in practice though it has been described as having influenced the industry more than the building industry itself has perhaps realised? This possibly is for two reasons, first it is a philosophy which has to be developed and this is alien to many quantity surveyors and the industry is conservative and reluctant to make any changes and second, it may alter the present responsibilities within the industry and its professions.

While the truly operational bill has not been known to be used in Great Britain except for research contracts, about nine bills were used in development trials in Eire. The transitional type of bill has been noted to have much wider use particularly for package deal type tendering. Little is known about usage of this type of documentation beyond a survey conducted by the Institute of Quantity Surveyors⁸, which

indicated that 28 per cent of their members had experience of using a bill of this nature once.

A successful offshoot of this work was achieved by Peter Thompson and Martin Barnes (now Dr Barnes) after agreement with Donald Bishop (now Professor Bishop) and the author. The upshoot was the innovation of Method Related Charges, etc. and these are now incorporated in the Civil Engineering Standard of Method of Measurement, 1976.

In the author's view Method Related Charges⁹ are the most realistic attempt now being applied in practice to reconcile the present conventions of quantities to the time scale of building. As a transitional move the development by the ICE is a bold step, although in itself this is not the sole solution to the problem of relating production to building costs.

The Need for Production Orientated Bills in Europe

Many quantity surveyors have assumed, now that the United Kingdom is a member of the EEC, that quantities are suitable for European practice and the quantity surveyor's service should be extended there.

Before presenting bills of quantities to Europe it must be queried whether they are meeting the full needs of the industry here? It is strongly contended by the author that they are not.

The problem of resource control has been highlighted as one of the principal constraints inhibiting development of efficiency in the European Building Industry. Sansom, who at the time, was possibly the most widely informed research worker examining communications in the European field, has supported this view and went further to postulate that any tendering documentation used there should be production orientated¹⁰.

The need to reorientate traditional communications towards the philosophy of production based documentation has been stressed too by many people like Clough and Bobrowski, etc. Moreover, a great need exists for improving the control of materials and reducing site waste. Further, as it has been demonstrated, because the principles of the technical accounting data base throughout the European building market are common¹¹, opportunities now exist for advising changes towards production orientated tendering in a larger market too.

The type of documentation which could be offered which meets these requirements is the bill of quantities (operational format). In the short term it overcomes the problems of traditional bills. As it is a transitional bill it requires little development, and could be introduced now throughout the European market because of the common data base, particularly if the preparation for its introduction was undertaken on an international basis¹². This type of bill lends itself to competitive, negotiated and "turn key" tenders. Moreover, it is useful to note that the greatest user in the United Kingdom is the building firm when preparing their own quantities. On the mainland of Europe where the majority of builders — general contractors — (or the equivalent, trades which cover the same work) now undertake similar tasks using conventional quantities when preparing bids. The transitional type of document thus

immediately could meet the common requirement of current European practice.

Production biased bills already have been used in practice at several places on the Continent, particularly in Sweden and are in limited use in France, similar type bills are under trial in Czechoslovakia and The Netherlands.

Accounting for Materials

The ideals of the production orientated bill in relating materials not only to purchasing units but to their location, offer many other opportunities for the post tender control of materials because one of the problems behind their waste on site is poor accounting. The presentation of tendering documentation which not only displays data for ordering materials, but helps to avoid potential waste, particularly when intricate designs are proposed, has many advantages. Moreover, using a production biased format ideally communicates information on the potential waste levels stemming from the design which would be overlooked using traditional quantities at the estimating and purchasing stages.

Concluding Discussion

At the tactical working level the present philosophy of technical accountancy fails on two important issues:

1. The price to the investor while being the present crux of all financial control both for the client and the builder, production costs cannot be realistically reconciled to this data base.
2. Design remains in isolation to the production process and the present incompatible communications often prevents value for money.

Further, the basic philosophy of building economics, i.e. the complete and realistic control of financial resources from inception to completion of a building's life cycle is at its best only partially practiced in one European area — Great Britain. Hence, scope exists for change in technical accounting practice in many areas.

At the present time the construction industry is particularly sensitive to the growing requirement for accounting of materials which has been principally high-lighted by recent studies into the considerable waste of materials on building sites¹⁴. This problem concerns the whole building team and the CIOB has recommended Production Orientated Tendering will considerably help ameliorate this problem¹⁵.

Lack of incentive to identify and solve these problems partly stems from the wide use of the term cost which is claimed to be one of the most confusing and undefined words in the building industry. For practical purposes the author feels the term "costs" when used in building communications should be clarified to mean production costs and reference to prices mean the client's costs. The misuse of words for both costs and prices occurs within the whole European market. An international study group indicated this problem too and terminology was a major constraint to developing the means of establishing the international exchange of price/cost data, which in any case is fraught with difficulties¹³. The Institute of Quantity Surveyors recognise this interchangeable use of the terms of "prices" and "costs" and recently their

Research Committee has restated, to avoid confusion in affairs of their Institute, the use of the term "cost" when referring to prices should be prefixed by the qualifying word "design".

The change required now to solve the financial resource control problems is to evolve a philosophy for not only the badly needed greater realistic control of investors' financial resources but for the means to control all those of the producer too.

The demand for efficiency in the building process will remain unsatisfied until an improvement is made to provide data which helps to bridge the gap between design and production. Clearly any move will incorporate better use of drawings. A strong case for a form of production orientated documentation exists today.

The further development (if any) of the operational type of bill remains very much an open question. When Mr Ian Hill (then Chairman of the SMM Committee) at a Gateshead lecture in 1970, given by the author, called the Operational Approach — "a damn good try" — he was forgetting Baden Hellard's simple work¹⁶, of combining drawings and the tendering data on one sheet of paper.

The need for production data in the field of quantities is accepted by many people and is included in the recent report of measurement conventions in the UK. But, it must be remembered, to make a compromise and retain existing principles, even if they work well, could in the long term mean no change at all, unless they are more clearly seen as intermediate moves.

The building industry has been slower than most industries to accept new ideas. Also at this stage as the Eighties open with its poor communications there has been little innovation in the building industry, putting its very future in jeopardy.

The operational approach offers in principle if not the results of many trials in practice, the chance to re-orientate the industry's thinking.

The final direction of any change remains fluid and open to the protagonists but in the shorter term surely more will be heard of operational drawings and the final type of bill may even eventually be in similar terms to Baden Hellard's. Most likely some development like MR in building work could be added to the seventh SMM too? Although this itself is not the complete solution, only dealing with part of the problem, it would be a move in the correct direction.

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INDUSTRIAL AIR POLLUTION 1979

Care and concern for the environment are now having to compete more with inflation, employment, difficult trading conditions, uncertainties about future plans and restricted finances says Mr Jim Beighton, Chief Inspector, in the foreword to the annual report* of HM Alkali and Clean Air Inspectorate published by the Health and Safety Executive. In these circumstances, he says, it is more than ever important that the best practicable maintenance and use should be achieved on means for control already installed and available.

While the report that emission control is beginning to benefit from an increasing interest in the use of computer technology to assist in the control of complex chemical processes, Mr Beighton, mentions, on a historical note, that the year saw the closure of the last works in Britain making saltcake (sodium sulphate). It was the uncontrolled emission of waste hydrochloric acid fume associated with this then important chemical process that led to the introduction of the Alkali Act 1863 and a little later to the concept of "best practicable means" of control. Best practicable means has been relied on over the years to cater for the very difficult problem of industrial pollution, particularly during the "clean air revolution" from mid-1950 onwards. Its application still remains as valid and valuable in current times, says Mr Beighton, but the scene and emphasis are again changed.

The report, which also includes aspects of the work of HM Industrial Pollution Inspectorate for Scotland, generally reflects subdued activity in the industrial scene it covers.

* Health and Safety — Industrial Air Pollution 1979. HM Stationery Office price £3.00 plus postage, or from booksellers. ISBN 0 118834258.