A PHILOSOPHY OF QUANTITY SURVEYING

Clyde Walker

A PHILOSOPHY OF QUANTITY SURVEYING

Inaugural Lecture

by

CLYDE WALKER
Professor of Quantity Surveying
Department of Quantity Surveying
University of the Witwatersrand
Johannesburg

Delivered 5 May 1975

Witwatersrand University Press
Johannesburg
1975

ISBN 0 85494 325 0
Witwatersrand University Press
1 Jan Smuts Avenue
Johannesburg 2001, South Africa

A PHILOSOPHY OF QUANTITY SURVEYING

Universality

A quantity surveyor has been defined as "a surveyor who estimates the quantities of the materials and labour required for any work"[1] but this has become expanded and modified through the work in fact done by quantity surveyors. Quantity surveying principles are also applied to the work of other disciplines. For example, cost engineering, which at first sight has nothing to do with quantity surveying, has been described by The American Association of Cost Engineers (AACE) as :

> "that area of engineering principles where judgment and experience are utilized in the application of scientific principles and techniques to problems of cost estimating, cost control and business planning and management science."

In addition, the membership of the AACE comprises chemical, electrical, mechanical and civil engineers and some quantity surveyors. It will become apparent later in this paper that the titles 'cost engineer', 'quantity surveyor', 'cost consultant', 'building economist' etc., are interchangeable and virtually synonymous.

An examination of publications related to cost and cost control in other disciplines as well as association and discussion with the members of these disciplines tends to emphasize the fact that quantity surveying principles can be applied to a wide range of activities. At the same time the various disciplines referred to can learn much from one another. For example, quantity surveyors could do well to examine the use to which statistical and other mathematical techniques are put by the other disciplines and they, in turn, could do well to examine the type of education given to quantity surveyors, particularly in the fields of the principles of systematic measurement, quantification and evaluation.[2]

---

1 The Shorter Oxford English Dictionary. Oxford University Press, London, Third Edition Revised with Addenda, Reprinted with corrections 1959, 1962, 1964, Vol.2 p.1635 col.3.

2 Observation of the author after a visit undertaken under a Norman Hanson Project Grant to the United States, Canada, France and the United Kingdom in June and July 1971.

Quantity surveying principles have also been used in cost control and evaluation in urban design[3,4] and are thus not limited to the functions previously given.

This apparent universality of quantity surveying principles together with the fact that quantity surveying is practised by people of varied disciplines leads to the conclusion that a large proportion of their calculations have a common base. Any common base for calculation can be stated as an algorithm which in turn can be written as a program for some piece of equipment which is either mechanically or electronically controlled. The development of such an algorithm will be dealt with in a thesis under preparation by the author.

Although the individual calculations referred to are simple, the problem facing the quantity surveyor and his colleagues of similar interests is complex when taken as a whole. This complexity tends to cloud the issues involved in reducing the problem to a manageable size particularly if, at the outset, an attempt is made to develop a method that provides all of the information required from all of the raw data available (i.e. a totally integrated system).

Because the services provided by those concerned with construction cost evaluation have been used for some considerable time it must be possible to establish the basis of their business and then through the elaboration of this basis to lay the foundation for an efficient, flexible, useful and economic system or method.

The Problem and the Services Required

In order to determine the basis of the business referred to it is necessary to define the problem, define the service required, examine the services provided and then determine the common factors in the services required and provided.

The problem referred to has been defined as follows :

> "The building team which includes the client has, in any building project, to solve the problems of producing, at the optimum final total cost, a building that functions efficiently, that can be erected rapidly and efficiently and that satisfies contemporary architectural standards."[5]

---

3 C. Walker. 'A Solution for New Township Cost Evaluation', 1971 AACE Transactions, pp. 207-212.

4 Sai-Hoo Yep-Sang Look. 'The Role of Quantity Surveyors in the Threshold Analysis Technique'. (Unpublished Master's Thesis).

5 Clyde Walker. 'Cost Consequences of Materials Selection', Building for the Future: Paper S11/2, p.3.

This definition is supported by other writers but with emphasis on other aspects such as cost-in-use, and the problem of meagre financial resources coupled with housing shortage.[6,7,8] Obviously the overall solution to this problem lies in the hands of the various members of the building team and the work of the professions in this team has been stated as :

> "In the building industry the professions have to consider public health, safety and amenity as well as aesthetics and economics. Public health and safety are essential but the appearance and state of maintenance of buildings are also important."[9]

This statement is too general to be used for the purpose set out before and a method of defining the construction cost consultant's work more precisely is to write the terms of reference that he would expect for any project for which he was professionally appointed. This was done by the author for an urban development project and resulted in the following :

> "To quantify, collate, analyse and evaluate the cost criteria and feasibility of the various town planning schemes, building designs and construction methods for the project and to report and advise on these evaluations in order that the client may decide on policy and detail."[10]

Although this quotation refers specifically to development the deletion of the words 'town planning' and 'building' is sufficient to make it universally applicable in building and construction. In order to make these terms of reference quite clear the words quantification, collation and evaluation, in the context that they are used, need amplification.

Quantification means the measurement of the component under consideration and the application of appropriate prices to this measurement to obtain its financial value. Collation means the collection, comparison in detail and verification of the various documents and information obtained. Evaluation means the consideration and comparison of all of the data produced.

---

6 G. Blachère. Research into Practice - the Challenge of Application, p.51.

7 J. Langdon. Research into Practice - the Challenge of Application, p.71.

8 D. Mohan. Research into Practice - the Challenge of Application, p.73.

9 Commission of Enquiry into Remuneration for Professional Services in the Building Industry. Report. Published by Authority, Pretoria, 1971. p.2. Extracts of report reproduced under Government Printer's Copyright Authority 5443 of 22.7.1975.

10 Clyde Walker. 'A Solution for New Township Cost Evaluation', 1971 AACE Transactions, p.208 col.1.

It now remains to examine the services of the construction cost consultant in order to determine whether there is anything which emerges as being the common factor.

Quantity surveying as a distinct activity has been traced back to the Great Fire of London[11] and some of the procedures such as 'measure and value'[12], the method of recording dimensions in a field book and the signing of Bills of Quantities by the person drawing them up are still in operation today.[13,14] Independent professional status was even claimed by Mandey in 1682[15] although Thompson points out that this was premature.[16] The three hundred years since the recognised beginnings of quantity surveying have seen the emergence of the independent quantity surveyor as well as the establishment and formation, in the last hundred years, of organized professional bodies of quantity surveyors.[17] This evolution has been accompanied by an increase in the services demanded of the quantity surveyor and it can be concluded that the development of the professional bodies has followed these demands.

In order to indicate the universality of the principles embodied in quantity surveying work it is necessary to discuss whether quantity surveying exists in countries not originally closely related to the United Kingdom where the term quantity surveyor has been in use for the longest period of time.

---

11 F.M.L. Thompson. Chartered Surveyors - the Growth of a Profession, p.66.

12 Ibid.

13 Ibid., p.69.

14 It is obligatory in terms of the Code of Professional Conduct of The South African Quantity Surveyors Act, 1970, for a quantity surveyor to 'sign' all documents prepared in his office.

15 Ibid., p.70.

16 Ibid., p.70.

17 The Institute of Surveyors (the forerunner of the Royal Institution of Chartered Surveyors) was founded in 1868 and the South African Institute of Surveyors (the forerunner of the Chapter of South African Quantity Surveyors, the Association of South African Quantity Surveyors and the South African Council for Quantity Surveyors) was incorporated in 1903.

It has often been said that quantity surveyors do not exist in North America. This statement is, however, not necessarily accurate. It is well-known that the system of producing Bills of Quantities in order to obtain tenders (bids) as known in South Africa is not practised in North America. Attempts have been made by U.K. based quantity surveyors to introduce the system to North America but this has not been very successful. The reasons for this lack of success may be that the contractors are either unfamiliar with the system, suspicious of it or simply resistant to change. All of this does not mean that bills of quantities are not produced at all because the contractors do, in fact, produce documents for themselves in order to prepare their bids. Bills of Quantities are also used in Canada as a basis for road works, dredging, etc., (i.e. civil engineering works) and in these cases the contractor is paid for work as done at the unit rates in the bills. Bills of Quantities are also used in the United States in some cases as the basis of contract between sub-contractors and main contractors and the unit rates in the bills are used for the settlement of accounts between them.[18] In addition, the profession of quantity surveying is established (even if in a modified form) in Canada and is organised under a body known as the Canadian Institute of Quantity Surveyors. This organisation has approximately 500 members and was started some 12 years ago. It is significant that this Institute has, in addition to members offering a general service, some who are only qualified to offer and provide a professional service for mechanical and electrical work. It is also interesting to note that an article published as far back as 1927 established that an American Institute of Quantity Surveyors existed at that time.[19] The article is a concise explanation of the quantity surveying professional functions as generally accepted in South Africa and it contains the following definition of quantity surveying which is substantially the same as given earlier in this paper :

> "Construction surveying is the science of measurement and tabulation applied to the physical members of a structure, expressed in uniform units of measurement with an analysis and detailed accounting of its requisite quality and quantity of material and labour applications."[20]

---

18 Information obtained by the author during a visit undertaken under a Norman Hanson Project Grant to the United States, Canada, France and the United Kingdom in June and July 1971.

19 Article from 'The American Engineering News Record' of March 3rd, 1927 entitled "Quantity Surveying and Survey" taken from a paper on "Economics Applied to the Construction Industry" by G. Szmak, Bridgeport, Conn., Secretary of the American Institute of Quantity Surveyors. (This article was kindly given to the author by Mr. D. J. Laing).

20 Ibid.

The function of the quantity surveyor is also neatly confined to its correct place in the article when Szmak says,

> "The profession is purely one of economics, the elimination of waste in the process of constructing architectural and engineering structures. It is not within the scope of the profession to design or erect a structure, these functions being handled by the architect and constructor."[21]

Language difficulties have prevented the author from examining the situation on the European continent but it appears from articles in "The Chartered Surveyor" as well as from advertisements for staff for European posts in the same journal that the profession of quantity surveying is spreading to that continent. In addition to this, the need for quantity surveying services in those countries where they are not in general use has been expressed in other documents.[22,23]

The evidence indicates, therefore, that the demand for services that fall into the category which requires quantity surveying expertise has come into existence through the needs of those who design, construct and pay for projects. This need has led to those people who have the aptitude for this type of work performing it even where there is no organized profession and, in addition, it has led to the recognition of the need for people educated in the discipline where this education does not exist.

Cost engineering, as can be seen by the following quotation, also apparently evolved from the needs referred to :

> "Recognition of the need for such cost-oriented engineers is exemplified by the formation in 1956, at the University of New Hampshire, of a new type of engineering society called the American Association of Cost Engineers (AACE). This organization is dedicated to the scientific development of the present art of cost predetermination and control from the research phase to operation of modern industrial plants. It covers the fields of cost estimation, cost control and profitability evaluations. The membership is composed largely of graduate engineers with many years of experience in their chosen fields."[24]

---

21 Ibid.

22 W. J. Diepeveen. Research into Practice - the Challenge of Application, p.219.

23 I. Paricio Ansuategui. Ibid., p.289.

24 H. Carl Baumann. The Fundamentals of Cost Engineering in the Chemical Industry, p.xiv.

The services provided by quantity surveyors, cost engineers and their allied colleagues have probably evolved over the years from the expertise, developed from an intimate and continuous association with quantification, price and cost, exhibited by them together with (certainly in the case of quantity surveyors) a progressive and aggressive formal educational policy. The fact that this expertise has appeared in different professional disciplines in differing parts of the world serves to reinforce the author's conviction that the common purpose is more important than the title, but this paper is, however, not the forum for debate on the exact name to be given to quantity surveyors, cost engineers, building economists, cost planners, construction economists, cost-surveyors, or anyone else offering similar services.

It is now necessary to examine the services provided by the people involved in cost evaluation in building and construction to determine the common base of these services.

As has been stated, quantity surveying started with the 'measure and value' system, and Thompson has drawn attention to the fact that this system, which consisted of measuring the actual amount of labour and material that went to make up the completed project and then pricing out these quantities either at rates agreed beforehand or fixed after completion, followed the emergence of the person who designed complete buildings on the drawing board.[25] The 'measure and value' method obviously did not provide any pre-estimate of the cost of the project and this could hardly have satisfied the more cost-conscious or impecunious owner. This led to his asking for 'lump-sum' quotations prior to construction which offered the quantity surveyor his opportunity to provide a service in the form of producing Bills of Quantities for tender purposes, at first for individual contractors and then for several contractors tendering on the same project. The natural development from this was the independent quantity surveyor who was in a position to settle the variations which inevitably are part of every contract (i.e. the settlement of the final account).

A digression at this point to examine, briefly, the service provided by quantity surveyors in Canada will help to indicate the common base in spite of the different emphasis and weaknesses in the type of service offered in that country.

---

25 F.M.L. Thompson. Chartered Surveyors - the Growth of a Profession, p.66.

In Canada the service consists of cost planning up to the point where bids are invited. Bills of quantities are rarely produced except for sub-contract work. Valuations for payment certificates are not done unless requested by the architect, in which case the architect pays the quantity surveyor for the service. Final accounts consist mainly of the arithmetic of adding up change orders (variation orders) because change orders are priced by the contractor and agreed when the change is ordered. However, if this agreement is not reached it is possible to call for an independent bid for the particular change order and to negotiate on the bid received. The author was not able to establish whether this condition was written into the contract or not but this apparently ideal system has snags because the author was also told that if change order prices were not agreed at the time of the change, "the wrangle starts". Reading between the lines this situation apparently occurs frequently.

The weakness of the Canadian system lies in lack of detailed cost control by the design team during construction.

Of the people interviewed by the author (excluding quantity surveyors, who naturally concurred) all agreed that a system of unit rates tied into the contract under the control of a quantity surveyor as used in the U.K. and South Africa was needed in North America.

The problem of cost control in the case of contractors who submit bids and after securing the contract look for extras through change orders was given as support for the use of a unit rate system and plumbing work was specifically mentioned in this connection.

The need for the use of a system of unit rates for bids for projects for which performance specifications had been prepared or for system building projects was also stressed. The significance of this statement may not have been appreciated by quantity surveyors in South Africa but a little thought indicates that it is quite conceivable that the role of the quantity surveyor in these fields could be as valuable as, if not more valuable than, the role played in conventional contracts.[26]

Returning to the evolution of the services provided by the quantity surveyor, the next natural step was for him to prepare monthly valuations of work done on the projects for which he had prepared the Bills of Quantities because he possessed all of the necessary data. In South Africa he performs the service and the responsibility for the payments rests with the architect under the usual conditions of contract.

---

26 Observations of the author on a trip to the United States, Canada, France and the United Kingdom in June and July 1971.

Because the quantity surveyor was continually dealing with costs and had the necessary data he was naturally drawn into the field of preparing estimates of the cost of projects before tenders were called and Thompson has pointed out that estimating methods in use today were coming into vogue some considerable time ago.[27] The extension of the estimating service to cost planning, budgetary control, cost-in-use, etc., has also been an evolutionary one and not one which is entirely new as quantity surveyors have kept cost information for some considerable time. (The author knows of at least one firm who kept records in the form of 'cube cards' showing the cost per cubic foot of a building before World War II).

What is relatively new, however, is the formalizing of cost planning and the placing of this service on a more scientific basis following the recognition by quantity surveyors in about 1950 that their methods of estimating needed improvement.[28] The extension and application of this service has been slow as was indicated by Nisbet in 1963 when he said,

> "The adoption of pre-planning for example has been advocated since 1950 and now, 12 years later, its use is far from widespread. Where the various techniques have been used there has often been a reluctant and grudging acceptance accompanied by a certain measure of arm-twisting."[29]

This was further stressed by Polding in 1970 in the following statement, "Cost planning techniques are now widely known even if they are not so widely used."[30] In the United Kingdom the formal recognition of cost research came with the approval by the R.I.C.S. Council of 1955-1956 of the Cost Research Panel and its formation in April 1956.[31] A similar need was recognised in South Africa and the Chapter of S.A. Quantity Surveyors (now the Association of S.A. Quantity Surveyors) established a committee known as the Cost Research Co-ordinating Committee in 1960.[32]

---

27 F.M.L. Thompson. Chartered Surveyors - the Growth of a Profession, pp. 81, 88, 89.

28 James Nisbet. 'The Role of the Quantity Surveyor during the Design Stage', The Chartered Surveyor, July 1959, p.21.

29 James Nisbet. 'Saving Time', The Chartered Surveyor, March 1963, p.487.

30 David Polding. 'Work of the National Building Agency', The Chartered Surveyor, February 1970, p.353.

31 The terms of reference of the R.I.C.S. Cost Research Panel on page 708 of their Annual Report.

32 Chapter of S.A. Quantity Surveyors. Guide to Elemental Cost Analysis, p.3.

All of these developments have been evolutionary and have been brought about by the demands of the clients but, as has been shown, the process of implementation of new services is slow, probably because it takes time to put new ideas into practice. Drucker has pointed out that the future "is being made today largely by the decisions and actions taken with respect to the tasks of today,"[33] and the need for the implementation of new techniques has been stressed by both Evenwel and Miners[34,35] but it is possible that the time could arrive when through lack of recognition of the basis of his business the quantity surveyor and his cost consultant colleagues could find themselves lagging behind the requirements of their clients.

The Common Base

As has been stated earlier, some of the activities of the quantity surveyor have remained virtually unchanged for three hundred years. At the same time because a universality of quantity surveying principles exists and because the present services offered and demanded have evolved from and have run parallel with the initial activity of the quantity surveyor, it seems reasonable to believe that there is some common base from which all activities start. In order to synthesize this common base the major present activities of the quantity surveyor are analysed in graphic form in Table I. Reference to this table, which makes no attempt to give a detailed description of each activity, shows that the analysis takes the form of an examination of the requirements of each service with the means employed to reach these requirements together with the necessary tolerances and a statement of the people likely to use or benefit from the service. Table I has been simplified into Tables II, III and IV in order to identify, more easily, the common factors related to the services.

Table II shows that in all cases evaluation in the form of measurement, description, collation, multiplication of unit prices by unit rates and accumulation of these products are prerequisites of the services.

---

33 Peter Drucker. Managing for Results, p.4.

34 J. K. Evenwel. Modern Building Methods, p.133.

35 T. W. Miners. Communications and Cost Control in Building Industry, p.92.

TABLE NUMBER ONE ANALYSIS OF QUANTITY SURVEYOR'S PRESENT MAJOR ACTIVITIES

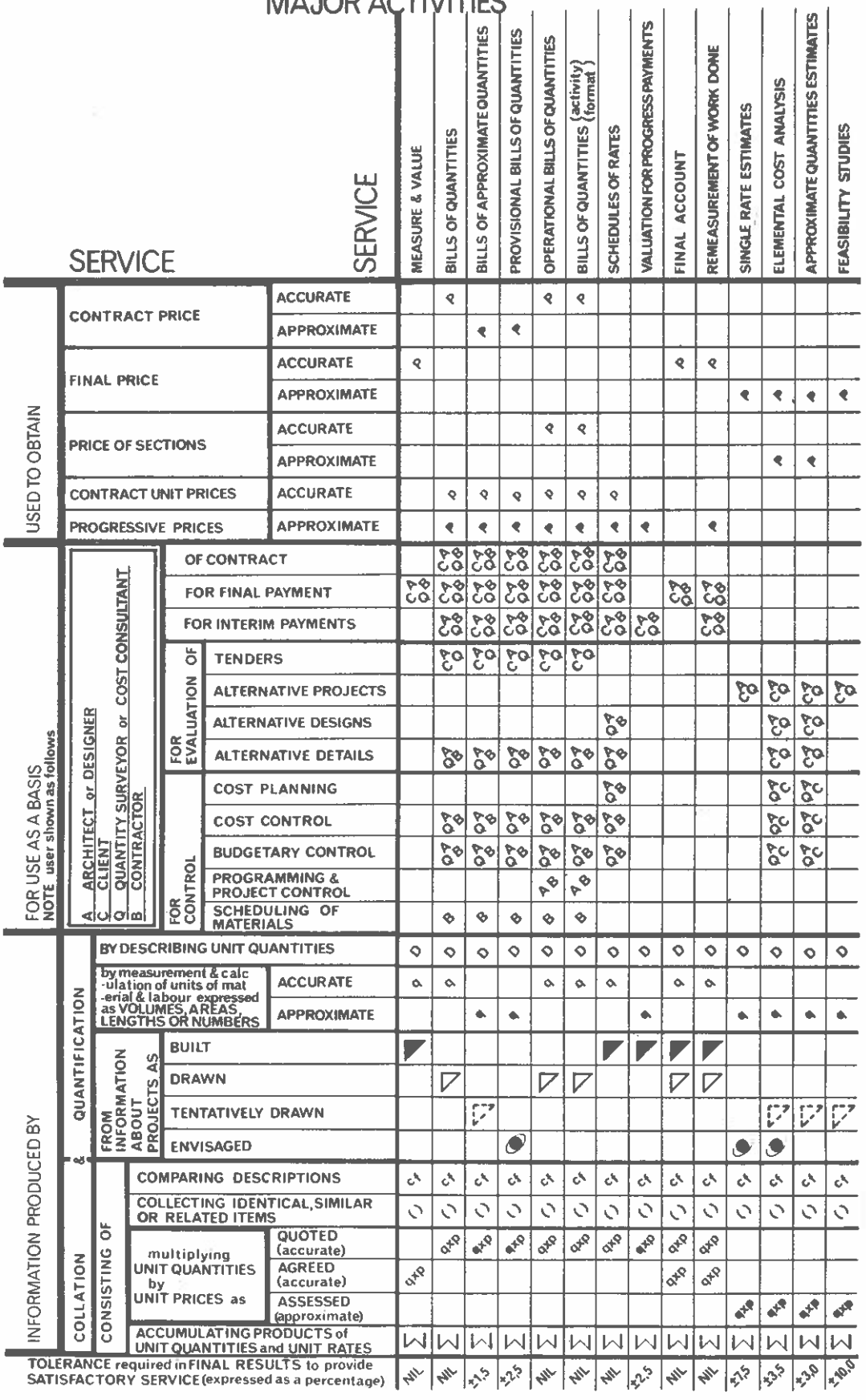


TABLE NUMBER TWO SHOWING EVALUATION

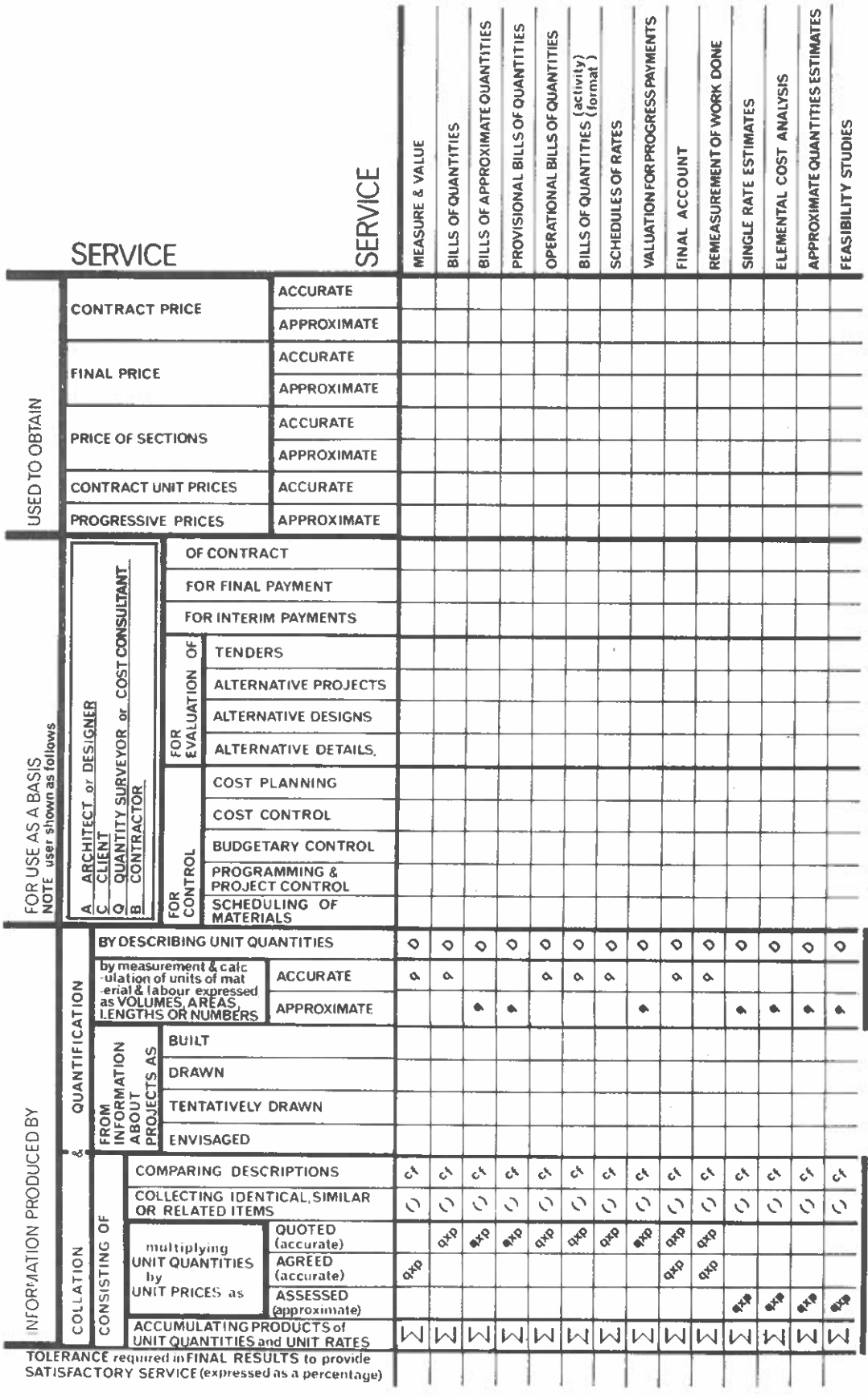


TABLE NUMBER THREE DISTINCTION BETWEEN SERVICES

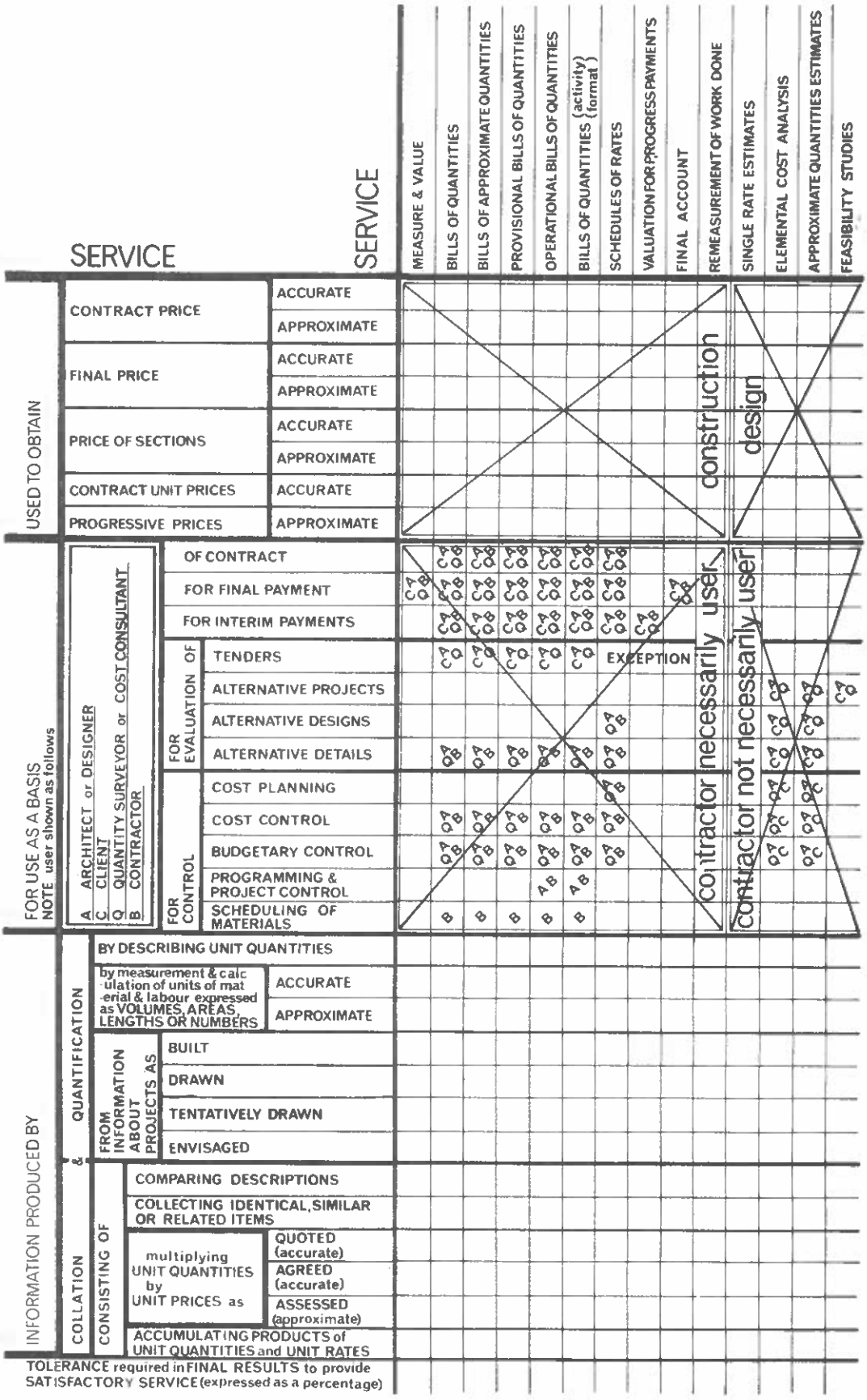
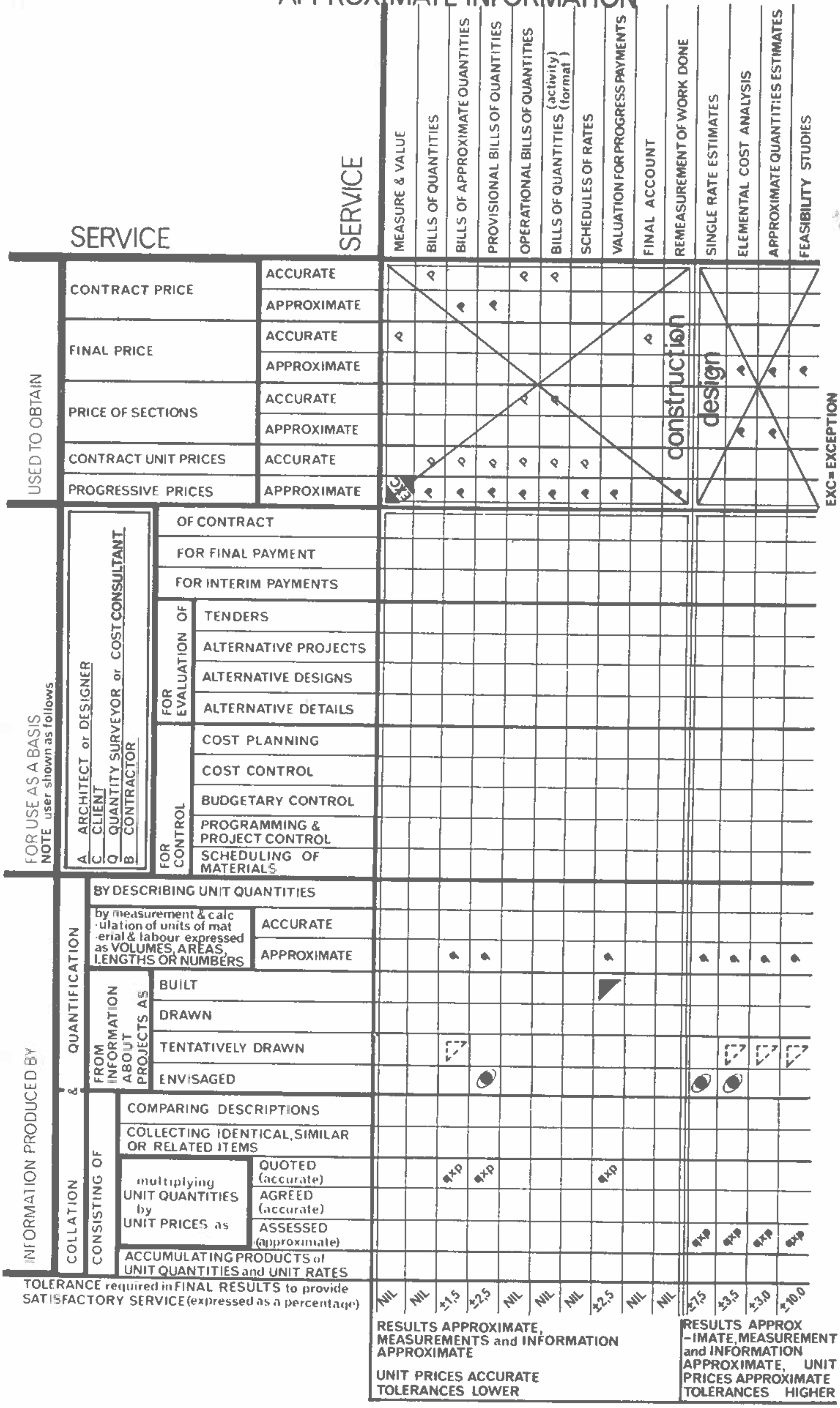


TABLE NUMBER FOUR RELATIONSHIP BETWEEN ACCURATE AND APPROXIMATE INFORMATION



Those services which are related to the actual construction of a project and those which are related to decision-making in design are given in Table III. This distinction is shown by the contractor necessarily being a user (except in the evaluation of tenders) where actual construction is involved and not necessarily being a user for decision-making in design. This leads to Table IV which shows that where actual construction is involved and the results are approximate, the measurements and information (except in the case of valuations for progress payments) are always approximate but the unit prices are always accurate and that where estimates are made for decision-making in design the measurements, information and unit prices are always approximate. This analysis shows that evaluation is the basis of the services but, at the same time, where approximations are necessary the permissible tolerances are dependent on the raw data available.

The basis of the quantity surveyor's business can, therefore, be defined as :

> "The evaluation, within limited tolerances, of projects in the construction industry through the measurement and analysis of physical size and cost."

It will be seen that this definition is compatible with the definitions of cost engineering, quantity surveying, the problem facing the building team, the work of the professions and the construction cost consultant's terms of reference. At the same time it does not limit the services which may be required and, therefore, includes any expected future functions of the quantity surveyor.[36]

Time

If the definition of the basis of the quantity surveyor's business is examined in isolation it is quite evident that no real problem exists in always providing the services required but it is not possible in the contemporary world to ignore the effect of time on any activity. The pressures produced by time have been referred to by many writers in different contexts. These cover the stimulated development and resultant increasing demands flowing from :

---

36 It has been expected that the future functions of quantity surveyors will be to predict, describe, control and appraise. See Ministry of Public Buildings and Works. Construction, Education and the Computer, p.24.

overemployment[37]

the increasing demand for quantity surveyors (implying a shortage)[38]

urgency created by the need to build quickly to satisfy a growing population and expanding economy[39]

the increase in size and complexity of projects and diminishing time available for evaluation[40]

co-operation related to the pressure of staff limitations[41]

waste of time if a scheme proves uneconomic at the tender stage[42]

time related to poor and wrong initial estimating[43]

the determination of final total cost as soon as possible after completion[44]

speed in preparation of documents[45]

increase in productivity to save time as opposed to gaining time by employing more resources[46]

the use of productivity measurement as a yardstick[47]

the need for sufficient time to enable a cost plan to be of use[48]

the production of information at the wrong time[49]

the waste of resources due to the illogical desire to conform to annual accounting periods[50]

the risks involved due to change of ideas, cost and economic climate over a long period of time[51]

---

37 J. K. Evenwel. Modern Building Methods, pp. 4,5.

38 Ibid., p.121.

39 Clyde Walker. 'Cost Consequences of Materials Selection', Building for the Future, Paper S11/2, p.11.

40 T. W. Miners. Communications and Cost Control in the Building Industry, p.68.

41 D. M. Calderwood and J. F. Van Straaten. 'Research Relating to the Requirements of the Users of Buildings', The Challenge of Modern Building, p.5.

42 C. D. Browning. Building Economics and Cost Planning, p.13.

43 A. T. Brett-Jones. 'Public Accountability and the Quantity Surveyor', The Chartered Surveyor, March 1970, p.406.

44 K. K. Dale. 'Future Practice and Procedure in Quantity Surveying', The Chartered Surveyor, December 1960, p.314.

45 Ibid.

46 James Nisbet. 'Saving Time', The Chartered Surveyor, March 1963, p.487.

47 Peter F. Drucker. The Practice of Management, p.68.

48 Douglas J. Ferry. Cost Planning of Buildings, p.19.

49 F. C. De Paula. Management Accounting in Practice, p.36.

50 A. T. Brett-Jones. 'Public Accountability and the Quantity Surveyor', The Chartered Surveyor, March 1970, p.410.

51 Oliver Marriott. The Property Boom, p.275.

This list of references is purposely long to emphasize that the pressures, effects and demands of time are many, varied and complex, and that time must be taken as a whole together with speed, efficiency and productivity, because it is a significant and limiting factor in all activities.

A Time-based Definition

This leads to a need to revise the previous definition of the basis of the quantity surveyor's business to account for the final constraint of time. The revised definition is then :

> "The rapid and efficient evaluation, within limited tolerances, of projects in the construction industry through the measurement and analysis of physical size and cost without waste of resources."

The Possible Solution

It has been seen that description, measurement and calculation are criteria essential to construction cost evaluation. This indicates that most of the problems associated with the time-based definition of the quantity surveyor's business can be solved by the use of equipment which can handle calculation and description separately, together or simultaneously. This implies the use of electronic or mechanical data processing equipment which is programmable and has storage facilities; but the use of such equipment requires that rules which can be clearly stated exist so that a system can be built up. At the same time, for any system to be efficient without waste of resources it must be economic, easy to use, and the results must be within the tolerances required.

Tables I to IV together with the explanations of these tables clearly indicate that a set of universal rules do exist for construction cost evaluation. These rules can be taken and developed into an algorithm for calculation which can then be incorporated into a whole system.

The problem inherent in the development of such a system is complex but not complicated, and has not yet been completely solved[52] and the way to the solution lies initially in the separation of calculation from description taking into account the need to reduce the number of times that raw data or prime information is handled manually together with the efficient use of men, machines, time and money.

---

52 It has been said that "There is a need to investigate the reasons for the disappointing experience of the profession in this field" (i.e. the use of the computer). See R.I.C.S. A Study of Quantity Surveying Practice, p.2.

The Educational Challenge

The universality of quantity surveying principles taken together with the definition of the quantity surveyor's business and the problem that remains to be solved represent a statement of the author's philosophy of the scope of quantity surveying.

At first sight it might seem that either the problems can be solved easily or that the philosophy is so simple that any educational challenges have already been met and overcome. On the other hand the scope of the philosophy can be seen to be so wide that the demands on quantity surveying are likely to be so great that the solution of one problem will lead to the recognition of yet another.

It is for this reason that the curriculum for the students reading for the degree of Quantity Surveying at the University of the Witwatersrand has recently been revised. This revision has given the whole course the necessary flexibility to take care of the changing needs of the future.

BIBLIOGRAPHY

Ansuategui, I. Paricio. 'The A.R.C. Method and the Architect'. Research into Practice - The Challenge of Application, International Council for Building Research, Studies and Documentation, 5th Congress, Paris-Versailles, June 1971: 289-294.

Baumann, H. Carl. Fundamentals of Cost Engineering in the Chemical Industry, Reinhold Publishing Corp., Chapman & Hall Ltd., London, v-xviii.

Blachère, G. 'Human Requirements - Topic 2 Users' Requirements'. Research into Practice - The Challenge of Application, International Council for Building Research, Studies and Documentation, 5th Congress, Paris-Versailles, June 1971: 51-53.

Brett-Jones, A.T. 'Public Accountability and the Quantity Surveyor'. The Chartered Surveyor, RICS, London, March 1970: 403-410.

Browning, C.D. Building Economics and Cost Planning, B.T.Batsford Ltd., London, 1961.

Calderwood, D.M. and Van Straaten, J.F. 'Research Relating to the Requirements of the Users of Buildings'. The Challenge of Modern Building, Proceedings Vol. 1, Building Research Congress, C.S.I.R., Pretoria, 1964.

Chapter of S.A. Quantity Surveyors, Research Co-Ordinating Committee. Guide to Elemental Cost Analysis, undated.

Dale, K.K. 'Future Practice and Procedure in Quantity Surveying'. The Chartered Surveyor, RICS, London, December 1960: 313-316.

De Paula, F.C. Management Accounting in Practice, Pitman Paperbacks, London, 1967.

Diepeveen, W.J. 'Response to Building Economics - Topic 8'. Research into Practice - The Challenge of Application, International Council for Building Research, Studies and Documentation, 5th Congress Paris-Versailles, June 1971: 219-220.

Drucker, Peter. Managing for Results, Heinemann, London, 1964, 1965.

Evenwel, J.K. Modern Building Methods, University of the Witwatersrand, Johannesburg, 1969.

Ferry, Douglas J. Cost Planning of Buildings, Crosby Lockwood & Son, London, 1964.

Langdon, J. 'Response to Topic 2 - Users' Requirements'. Research into Practice - The Challenge of Application, International Council for Building Research, Studies and Documentation, 5th Congress Paris-Versailles, June 1971: 71-73.

Marriott, Oliver. The Property Boom, Pan Books Ltd., London, 1967.

Miners, T.W. Communications and Cost Control in the Building Industry, C.S.I.R., Pretoria, 1971.

Ministry of Public Building and Works. Construction, Education and the Computer, Conference Report, Cambridge, 1968.

Mohan, D. 'Response to Topic 2 - Users' Requirements'. Research into Practice - The Challenge of Application, International Council for Building Research, Studies and Documentation, 5th Congress Paris-Versailles, June 1971: 73-74.

Nisbet, James. 'The Role of the Quantity Surveyor during the Design Stage'. The Chartered Surveyor, RICS, London, July 1959: 20-25.

Nisbet, James. 'Saving Time'. The Chartered Surveyor, RICS, London, March 1963: 487-489.

Polding, David. 'Work of the National Building Agency'. The Chartered Surveyor, RICS, London, February 1970: 352-355.

Royal Institution of Chartered Surveyors. A Study of Quantity Surveying Practice, conducted for the Quantity Surveyors Research and Information Committee, The University of Aston in Birmingham, RICS, London, 1974.

Sai-Hoo Yep-Sang Look. 'The Role of Quantity Surveyors in the Threshold Analysis Technique' - A Thesis presented in accordance with the Requirements of the Heriot-Watt University for the Degree of Master of Science. Edinburgh. September 1971.

Thompson, F.M.L. Chartered Surveyors - The Growth of a Profession, Routledge & Kegan Paul, London, 1968.

Walker, Clyde. 'Cost Consequences of Materials Selection'. Building for the Future, Second Building Research Congress Proceedings, Vol. 1, National Building Research Institute, C.S.I.R., Pretoria, 1969: S11/2, 1-13.

Walker, C. 'A Solution for New Township Cost Evaluation'. 1971 Transactions of the American Association of Cost Engineers, 15th Annual Meeting and 1st International Cost Engineering Symposium, pp. 207-212.

ACKNOWLEDGEMENTS

I wish to thank the following copyright holders for permission to quote from their publications :

The American Association of Cost Engineers
The Royal Institution of Chartered Surveyors
the Editor of Chartered Surveyor and
the Government Printer, Pretoria