MODERN DEVELOPMENTS IN COST MANAGEMENT

IMPLICATIONS FOR MANAGEMENT ACCOUNTING IN THE CIVIL ENGINEERING INDUSTRY

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This paper may be quoted, but through both academic and practical interest the authors would appreciate being informed. Comments always gratefully received.

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INTRODUCTION.

After decades relative stability in cost accounting, the increasingly competitive environment through the 1980s and 1990s has been the prime stimulus for a range of new developments in cost identification, cost management and, possibly to a lesser extent, in broader aspects of financial control concerned with responsibility accounting. These developments were mainly initiated in companies related to the motor industry and high-tech companies in industries like computing and electronics where the competitive threat from Japan in particular was severe, although changes in cost accounting practice were by no means observable only within such industries. These developments have not, however, spread widely to the civil engineering industry. The first aim of this paper is, therefore, to outline the current state of the art in cost accounting and cost management theory and practice in manufacturing industry and then, as a second aim, to discuss the extent to which developments are applicable as a basis for developing a world class management accounting function for the management of large scale civil engineering projects - i.e. the construction of roads, bridges, tunnels, etc. The paper is structured into two main sections to reflect these two principle aims.
SECTION 1. RECENT DEVELOPMENTS IN COST ACCOUNTING AND ACTIVITY BASED COSTING (ABC) AND ACTIVITY BASED MANAGEMENT (ABM)

There are two traditional forms of product costing: full Absorption costing and Variable (sometimes called marginal) costing. Under absorption costing the cost of products is estimated to include all direct and indirect manufacturing costs irrespective of whether they are variable or fixed in relation to changes in the level of output produced. Direct product cost is defined as those costs which can be easily traced direct to the product. Hence, the cost of the material content of a finished product and the cost of labour working directly on the production line are, traditionally, the prime elements of direct product cost. Indirect manufacturing costs are all other costs incurred in the manufacturing process.

The manufacturing costs of products under absorption costing are used to specify stock (inventory) amounts in the balance sheet and trading account where the valuation rule is to show stocks at the lower of their manufacturing cost or market value. For internal management purposes, businesses may also wish to attribute a share of non-manufacturing costs to individual products or product groups in order to compare the full cost with selling price and thereby determine the profitability of each product or product group.

Variable costing differs from full absorption costing in only one key respect. Only variable costs (i.e. those assumed to change in strict proportion to changes in the level of output) are considered to be the costs of products. This will include both direct and indirect variable costs. For balance sheet and trading account purposes this will mean that the cost of stocks is based on only variable manufacturing costs. But, for management purposes, businesses may attribute both manufacturing and non-manufacturing variable costs to products in order to estimate each product’s (or product group’s) contribution towards profits and fixed period costs. (The contribution for a product is simply its selling price minus the variable cost per unit). Under variable costing, fixed costs are simply treated as a cost of doing business in the period and not a product cost.

It is important to recognise that under both absorption costing and variable costing, product cost will be the sum of direct costs plus a share of indirect costs. Under absorption costing both fixed and variable indirect costs are assigned to products; under variable costing only variable indirect costs are assigned to products. It is important to stress this because debates about cost accounting are often conducted as though the overhead cost allocation problem arises only in absorption when it also arises in variable costing although to less extent.

Unless otherwise stated, the following description in this section of the paper applies to absorption costing. In addition, the cost allocation in a manufacturing firm will be described because that is where Activity Based Costing (ABC) originated.

Activity Based Costing concerns itself with the way in which indirect costs (all indirect costs including both manufacturing and non-manufacturing indirect costs) are best associated with the production of different products and product groups.
therefore, necessary to consider the traditional method for doing this, before considering what changes supporters of ABC propose. Of course, systems of cost allocation will vary from firm to firm, but one can describe the traditional nature of general practice.

Conventionally, the cost of products for balance sheet purposes was constructed as follows:

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\text{Direct product cost (direct materials plus direct labour costs)} + \text{Indirect manufacturing costs} = \text{Total manufacturing cost}
\]

To obtain a full cost estimate, including non-manufacturing overheads, for management purposes, it was often convention simply to add a percentage of Total manufacturing cost to cover non-manufacturing costs.

Indirect manufacturing costs for each product (product group) were usually assigned to products through a two stage process. First, one would separate out the indirect costs incurred directly in the manufacturing processes (e.g. plant depreciation, supervisors’ wages, factory cleaning, costs of utilities) from the costs incurred in service operations (e.g. personnel, buildings and grounds, machine maintenance) which supported manufacturing. More sophisticated systems would trace costs of support services to different production departments using factors which seemed most appropriate. For example, one might use number of employees in each production department to allocate personnel costs, square footage to allocate buildings and ground costs or actual work tickets to charge out machine maintenance. The support services costs would then be added to the indirect product costs incurred in each production department and the sum of the two would be allocated to products which used the processes in each production department. The allocation of the indirect product costs to products was traditionally, and still is widely, performed on a direct labour basis. That is the total indirect manufacturing cost in each department forecast for the year would divided by the budgeted number of products to be produced times the estimated labour hours required to produce each one - this would yield an indirect cost per labour hour which would be multiplied by the actual hours taken in that department by each product in order to work out its share of indirect manufacturing costs. Figure 1 outlines the whole system.

Figure 1 shows costs of four Service Departments assigned and added to the indirect product costs incurred in two Production Departments (PD1 and PD2) which are then allocated to products at rates appropriate for each product as it passes through each Production Department. Some systems also re-allocate costs between Service Departments before assigning them to Production Departments. Some systems do not differentiate between separate production departments, but use one blanket rate for
allocating overheads to products related to total labour hours used by products in all stages of production.

Traditional systems do not necessarily use labour hour bases for overhead allocation. Other bases used include a direct labour cost basis, a direct materials cost basis or machine hours basis with a tendency towards a growth in the latter as production becomes more dominated by technology in many industries. ABC advocates usually claim, however, that the labour hour or labour cost basis is still the most widely used basis.

SUPPORT SERVICES COSTS

Having described a traditional cost allocation system, it will now be possible to demonstrate the essential difference of that system from ABC.

ABC supporters argue primarily that costs in modern manufacturing firms, with their reliance on CAD / CAM and CIM are less and less driven by the employment of direct labour. Moreover, a large proportion of costs do not vary with other measures of production volume either (e.g machine hours). The ABC position is that if one wants to understand fully how costs change, one needs to establish exactly what the determinants of costs are. This applies both to manufacturing and non-manufacturing
costs. One needs, in other words, to discover what *drives* costs. While ABC supporters would agree that many costs may still vary according to the number of direct labour hours or machine hours worked, a growing element of total costs have different cost drivers. These might, for example, be the number of set-ups required for production or the number of orders placed to procure materials or the number of deliveries to be made to customers. If different products, production batches or product groups have a different call for numbers of production set-ups, etc., then it will only be possible to estimate an accurate product (product batch, product group) cost by reference to these cost drivers.

The difference between ABC and conventional absorption cost accounting is, fundamentally, no more than that. In fact some have argued that it was always possible for a variety of cost drivers to be made in traditional systems and so ABC systems are not really significantly different. The principal advocates of ABC respond that even if this is so, companies have not, in general, been operating that way and they are concerned more with changing practice than debating the appropriate terminology. Moreover, ABC eschews allocating costs first to Production Departments if it is not necessary and it also applies the cost-driver logic to all costs and not just manufacturing costs.

Many companies in many industries have now experimented with or applied ABC. Notable case studies exist which indicate that, where companies have introduced ABC, it has radically changed their perception of the profitability of different products compared to that held under previous costing systems dominated more by labour cost / hour bases of overhead allocation. Some found that many products that they were producing were, in fact, loss making and that they had simply not realised this. Several notable companies have significantly changed their long run product mix strategies as a consequence. It is also noticeable that the spur for change for some of these companies was a realisation that past profitability was disappearing in the face of increased competition and that a better understanding of their product costs was vital to meet this threat. For such companies, ABC was a vehicle for product pruning and “downsizing” which enabled them to refocus on their profitable core business. Initially, therefore, one might have conceived of ABC as a “corporate turnaround tool”. Something required when a company is in need of a radical re-think of where it will operate in future if it is to remain profitable. The implication is that, once profitability, returns, ABC does not become so critical. In addition, it may not be necessary to use a full-blown ABC system for regular cost control at ,say ,monthly intervals where product mixes are not changed frequently and total product costs do not change radically. Hence, ABC analyses, which can be rather detailed, may only be needed when strategic reviews of product mix takes place.

Other accountants have, however, stressed that it is fundamental to know exactly how costs are generated if one wants to try continually to manage costs down. A vital part of continuing improvement is, therefore, up-to-date ABC based estimates of costs. Only then can one see the cost consequences of changing the batch size (number of set-ups) or numbers of orders placed or delivery times and frequencies or other key cost drivers. Even a company not under threat may, therefore, need ABC estimates in order to keep free from threats by remaining, for example, a cost leader in the industry.

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^ Mainly in Western countries. There are, for example, very few examples of ABC in Japan.
Activity Based Costing then becomes the basis of Activity Based Management. Budgets can also be drawn up on such a basis integrating activity based cost savings with budget targets (Activity Based Budgeting).

Once one moves in that direction, however, it is important to note that the type of cost drivers discussed by advocates of ABC are usually only first level cost drivers. While the number of set-ups may well determine the level of a significant part of manufacturing overheads given the existing plant layout, the number of set-ups themselves may be determined in part by the plant layout. The plant layout may in turn be partly a function of the type of plant used or the factory space available of the particular location of the plant. Hence, there is really a complete hierarchy of cost drivers above the first level cost drivers used in ABC product costing which stretches up, in theory, to the existence of the whole entity itself. Consequently, cost reduction programmes should not just be confined to the use of “conventional” ABC data, but should also consider “re-engineering” processes in more radical form. The advantages of operating at this higher level of cost driver may swamp the benefits to be derived from modifications to production and non-production processes derived from insights gained by ABC. But then they may not - and radical re-engineering is not always feasible or necessary. The specific context in which cost reduction is being sought will be important in determining the cost reduction approach to be adopted.

**Cost of Quality Calculations in Support Of TQM**

Quite a different, and rather earlier, accounting development introduced the idea of calculating the cost of not getting things right first time. This has been termed the Cost of Quality (COQ) but should perhaps have been called the cost of poor quality or the cost of non-compliance. This development grew out of TQM developments and the Japanese pressures to reduce parts per million defects. It is sometimes stated that the Japanese did not extend their development of TQM to link with accounting in the form of COQ procedures and that these were a product of more Western thinking. One argument for this is that, initially, the Japanese realised that they had to get defect rates down in terms of delivered products to customers as a key plank of their marketing strategy and that this then fed back through the total production process and led to a focus on moving to zero defects as a physical process rather than wanting to know the costs that could be saved. In the West, it is sometimes argued that many senior company executives had to be convinced first that this was an appropriate policy to adopt and COQ estimates were developed as a means of convincing such executives that a move to radical defect reduction could have a major impact on the bottom line.

It is important to realise what “quality” means in this context. Quality means producing something or giving a service which complies with a pre-determined specification and achieving that first time without the need for alterations or amendment. The COQ is, however, more than just re-work costs, although that may constitute a significant element of COQ.

Most applications of this concept have attempted to estimate costs in four categories:

- Prevention costs
- Inspection costs
• Costs of errors discovered on the firm’s premises

• Costs of errors only discovered once the goods have left the firm

Prevention costs are incurred by all those activities which are undertaken because the firm cannot trust everything to be done right first time without those activities. This might include training, planning, supplier assurance, analysis of data to prevent future failure and, indeed the cost of COQ programmes themselves. Inspection costs include the costs of all those activities that are undertaken to ensure that errors have not occurred. These will include testing equipment, inspecting work-in-progress and finished goods, inspecting goods received, inspecting stock levels and condition. Costs of errors are usually divided, as above, into internal failures and external failures. Internal failures might include the cost of scrap materials and scrapped items, the cost of re-work, the cost of defect analysis, re-inspection and testing, sub-contractor failures, etc. External failures will include penalties and warranty claims, the costs of handling, examining and reworking returned goods, and, where possible, should also include the cost of lost goodwill or future business.

By undertaking a COQ analysis, it is possible to see the total estimated costs of not getting things right first time. Such costs are not visible in conventional accounting statements and usually need some effort to obtain.

Studies in various industries have suggested that companies that have not undertaken such exercises before often discover that something of the order of 20% of total costs are incurred through failures. This does not mean that those companies can immediately get rid of those costs. Management methods have to be found to ensure that errors do not occur. Practices and organisational culture has to change. Operatives have to accept responsibility for ensuring that errors are not made and given the necessary support and training to do that. Often this leads to increases in Prevention costs in the short run - especially relating to improved planning. However, internal and external failure costs are usually heavier than prevention and inspection costs, especially if any errors still remaining are discovered earlier in the production process, and so there will be net gains even in the short run. As the error rate improves, it should then be possible to work on reducing prevention and inspection costs.

There has been much debate over the value of COQ estimates. Some managers, like the Japanese apparently, argue that there is no need to estimate COQ costs, companies should just focus upon avoiding errors. Others see the value of having COQ estimates to convince senior managers that quality control has huge potential for increasing profits. Even a 10% savings in total costs will do wonders for the “bottom line”. Some have argued that they agree with this, but feel that once the improved quality consciousness is instilled into the organisation, one can dispense with the COQ estimates. Others, especially in industries where products are regularly redesigned and new ones, with relatively short life cycles, introduced, have linked up the notion of COQ improvement with notions of the “learning curve” and monitor production cell achievement against standard time-cost reduction curves (sometimes referred to as half-life functions).
**Target Costing**

Target costing has been given much more attention in Japan, but is increasingly being taken up in the West. It is linked with both Functional Cost Analysis and Value Engineering in order to design products and services which have the attributes that the market requires at the price that it is prepared to pay.

The initial step is to study the market place to identify the attributes that the next generation of products must have and the maximum selling price. This does not mean that the company simply provides what the market says it wants. The company may have superior knowledge of what can be provided. Depending on the type of market, there may well need to be considerable interaction between supplier and customer at this stage to decide on the bundle of attributes that will best meet the customer’s needs (this may extend to trying to understand the customer’s customers needs too). This will usually also involve a marketing analysis to identify market segments and how product attributes fit with each segment. It will also involve understanding the capacities of rival companies to deliver such attributes at the relevant costs.

The next stage of the target costing process is to identify what activities the company must embark upon in order to deliver those product attributes. These activities are then costed and the total cost compared to the cost level likely to be consistent with selling at the acceptable market price after deducting a desired profit. In the event that the allowable cost exceeds the predicted cost, the company then embarks upon Functional Costing and Value Engineering routines to identify where costs can be reduced without destroying the required product attributes. This process continues until the predicted cost has been reduced to a level which, with a profit margin added, is consistent with the required market price. When this stage has been achieved, the company is ready to go ahead with its plans for investment in order to produce the product in question.

Functional Cost Analysis and Value Engineering both contribute to the search for viable cost reductions within this process. In outline, Value Engineering employs multidisciplinary or multi-functional teams to examine the specification of the product and, through intensive and creative study, reconsider how that specification can be delivered with alternate product designs or through different production processes. This Value Engineering process usually has at least two main stages: the first, early in the concept development stage, considers more radical design alternatives in terms of changing major components provided that the service required from the product can still be delivered. The second stage, coming after the concept has been largely set, usually uses separate teams to address different parts of the product design to see whether the functionality of those specific parts can be increased at no extra cost or whether the part can be reduced in cost with no loss of functionality.

Functional Cost Analysis may be used at both levels to help to focus this search by comparing the actual cost of incorporating different attributes into the product with its value as perceived by the customer / market place. The value attached by customers to particular and specific product features is not obvious from market data. Customers buy products as bundles of attributes for an all-encompassing price. There may be evidence of product variations and different market prices, but this is unlikely to be
sufficient to identify the separate values of all major attributes. One approach to
resolving this question is to ask customers (or company staff acting as if they were
customers) to give weights indicating the relative importance attached to each of the
main product attributes. The total product price is then allocated over the components
according to those weights and the “product price allocation” for each attribute
compared to its costs. Clearly one may question how rigorous such a process is for
arriving at the precise market value of each attribute, but that would be to miss the
point. The aim is to get an approximate idea of the monetary value of each attribute. If
such an estimate is far below the cost of incorporating it into the product, this is taken
as a signal that here is an area that should be subjected to cost reduction.

The distinguishing feature of target costing is its ex ante nature. Traditional Western
costing is usually described as a process of identifying costs of products as they are
being produced with prices fixed by adding a profit element to cost. Target costing
says more of the detailed costing should take place at the design stage, after all most
major cost elements of many manufactured products are committed at that stage and
there is limited scope for reduction thereafter. Target costing does not start with
product cost, but with market price; it then deducts the profit element to leave
allowable product cost as the residual. As used in Japan, this approach also seems to
have the advantage of enabling the enterprise to operate with less detailed costing
systems for ongoing operations. Where more detailed cost planning is taken in advance
in conjunction with marketing and engineering functions, it is more likely that the
products will be acceptable to the market and that they can be produced at the
appropriate cost. Hence, cost accounts can be kept in more aggregated form and focus
more upon whether more aggregated budgeted goals are being met, rather than very
detailed product costing of goods as they are produced.

**Kaizen Costing**

*Kaizen* costing also has a Japanese heritage. *Kaizen* refers to the process of seeking
continuous improvement. Some Japanese companies link a target costing planning
process with a *kaizen* process once the products are in production. Other companies,
for example those with short to medium product life cycles, place more focus upon
target costing. Their approach to continuing improvement is to have several
generations of products at different stages of design and development (i.e. different
stages of target costing). Other companies, in more mature markets with longer
product life cycles, place more emphasis on *kaizen* during operations.

*Kaizen* essentially tries to ensure that everyone in the company continually reconsiders
how the task is undertaken and whether there is a better way of doing it. It is not so
much a costing routine as the outcome of developing an organisational culture of
collaborative learning at all levels of the company. There were precedents in the West
in terms of learning curves (which projected the extent to which direct labour costs
could be reduced through learning undertaken in a repetitive activity) and experience
curves (which traced how all costs could be reduced as a task was undertaken more
and more times). There is certainly some element of this in *kaizen*, but the latter is even
more encompassing than experience curves in so far as it does not just depend upon
experience to identify improvements, but encourages the use of intelligent and shared
thought and action through work-teams to search for improvements.
It is clear that one approach to seeking continuous improvement would be through following up Cost of Quality analyses as described earlier in order to trace root causes of not getting things right first time and removing them. As indicated earlier, some companies have borrowed from the learning/experience curve notions and established cost curves which indicate the rate at which *kaizen* learning ought to take place. Sometimes these are expressed in terms of half-lives, that is the time it takes for costs, or machine failures, etc. to fall to half of what they were at the beginning of each period. Progress in continuing improvement is then monitored against these half-life functions.

**The Theory Of Constraints (TOC)**

The Theory of Constraints is not a cost accounting method, but it has far reaching implications for cost management. The theory was developed by Eli Goldratt who subsequently established the Goldratt Institute to extend the practice of the theory. The initial motivation for developing the theory was to seek an improved way of production. It was designed to identify the most efficient way of increasing production throughput. Goldratt and Cox argued that the pace of the slowest process in the production run determined the pace at which production could function. Hence, everything had to be geared to ensuring that there were no delays in that slowest part of the process. Unlike JIT which has the goal of eliminating all inventories, TOC allows for a minimum buffer of stock to be held immediately before the process with the slowest pace so that unexpected interruptions in delivery from the other processes will not delay this critical process.

It also follows from Goldratt’s analysis that, in order to improve throughput, which is not the same as reducing cost, attention will be best focused on increasing the rate at which that one constrained factor operates. TOC supports the notion of continuing improvement and after some point by improving the rate of production on the critical process, that process will itself cease to be the constraining resource. Then attention should be shifted to the new critical process. In this way Goldratt provides a logical path for more efficient continuing improvement of throughput rates. This must not be confused with the most logical way of cost reduction, because this could well be achieved by paying more attention to non-critical processes. However, Goldratt argues that TOC would prefer to focus on improving throughput first, then cutting out inventories in excess of the minimum buffer stocks and lastly in cost reduction.

Later developments of TOC have moved far beyond improving production. TOC is now directed to “improving everything”. In the Goldratt Institute’s view all problems can be resolved by a process of identifying constraints and removing them. In pursuing this goal, Goldratt also developed what he called his “Thinking Process” which is essentially a set of logic trees for identifying what factors are causing the constraints and how to remove them. A particularly interesting observation that he makes is that after tracing back to root causes it is valuable to ask why these causes have not been removed before. The answer he says often lies in different assumptions held by different people about what they and others have to do to optimise the system. Change these assumptions (mind sets) and removing constraints can often become much easier.
Goldratt also suggested that his TOC should be supported with some new and specific measures of performance. These are (I) Throughput Dollar Days and (II) Inventory Dollar Days. These may be explained quite simply.

Throughput Dollar Days is a new measure of due date performance. If an order is late, it is given a value equal to its throughput (sales less direct materials costs) times the number of days that it is late. The department in which the work is currently situated bears this charge as a cost. The objective is to make departments very aware of the need to maintain throughput and deliver on time. It may be unfair to charge a department with such a cost when the delay was caused by some earlier process in another department, but Goldratt argues that this practice will create a “hot potato” and induce all departments to pass it on quickly.

Inventory Dollar Days has a similar philosophy. A calculation will be made to indicate how long it will take to reduce any excess inventories beyond the agreed buffer level to that buffer level at the normal rate of usage. If, for example, there was an excess above the buffer level of 40 units in stock and the normal rate of usage was 20 units per day, this would imply that it will take two days to remove the excess inventory - an excess of 20 units will be held for one day and an excess of 20 for two days. The inventory day measure will then be 20 x 1 plus 20 x 2 = 50 inventory days. The number of 50 will then be multiplied by the value of each unit of stock in order to derive a measure of Inventory Dollar Days and departments will be held accountable for any such dollar days. (This measure would not normally be used to value stock in accounting reports). The intention once more is to have a measure of undesirable performance which escalates rapidly as stock is held for an excessive time, thereby highlighting the matter.

Even though a number of companies have adopted a Theory of Constraints approach to managing their operations, very few seem to have adopted the Inventory Dollar Days measure mainly because the implied cost of holding excess stock was seen itself to be unrealistic. The cost of holding stock does not normally double between day 1 and day 2.

**Throughput Accounting**

Throughput accounting arose from Goldratt’s thinking in developing his Theory of Constraints. In developing his theory, Goldratt was initially trying to maximise the profitability of the firm by maximising the amount that could be produced given existing production configurations and constraints. He argued that plans will be drawn up to maximise production (throughput) and that once these plans have been established no section of the firm should depart from them or the co-ordinated plan would be upset. It follows that each department could be seen as having a fixed budget to spend to meet its target.

Under this form of operation, Goldratt argued that no benefit, and perhaps a lot of harm, came from existing cost accounting practices which allocated indirect costs, variable and fixed, over products and / or product groups. Given a clear co-ordinated plan, all the firm needs to do is maximise throughput measured in aggregate financial terms as sales less direct materials costs and see that the throughput measured in financial terms exceeded the fixed operating expenses by as much as possible. In other
words, he defined all costs as fixed except direct materials costs. Subsequently, he has softened his stance, to allow that other costs may also be variable, but still stresses that direct materials costs are the main variable costs.

Throughput accounting, as defined by Goldratt, is not really a new form of accounting. It is merely an extreme form of variable costing. If the only costs which are truly variable are direct materials costs, there will be no difference between throughput accounting and variable costing. Moreover, if the focus of decision-making is on maximising throughput in the short-term, given existing resources, throughput accounting may well approximate the true variable costs. As one lengthens the period of decision-making, however, such that excess labour may be laid off or other indirect cost services varied, it is clear that throughput accounting would not support appropriate decision-making. At the limit, if the firm is contemplating severe product line pruning, ABC with its sophisticated approach to cost allocation will provide the best guide to relevant costs. There ought not, therefore, to be a controversy over whether TA or Variable Costing or ABC (full costing basis) is best - they each serve different purposes. Of course, companies will not run their routine costing systems in all three forms. As data base methods become more widely available and applied to accounting, it should be possible to generate accounting data with the appropriate form of cost variation assumption for the decision at hand and use the concept most appropriate for measuring managers at different levels according to their personal responsibilities and functions. The accounting skill should be to provide relevant costs for the purpose for which they are required - this has always been the case and TA offers nothing new to that basic concept.

**Integrated Strategic Management Accounting**

Strategic Management Accounting is not a new costing system. It is a generic term which covers the use of cost and management accounting to help inform an organisation in making major strategic decisions. In this sense, all the methods described above have a role to play. More recently, however, the term has been used more precisely (see Carr and Tomkins, 1996) to describe how accounting needs to be integrated with strategic thinking in order to provide a comprehensive control system. Essentially, Carr and Tomkins, draw up a framework for system design which integrates all, or most, of the new developments described above and it does so through a general target costing approach to strategic investment decisions - i.e. those decisions concerning new markets, new products or the acquisition of new attributes by the company in order to give it a better market standing.

The process will first involve a consideration of what customers need and what rival companies can deliver in order to arrive at a project description in terms of product / service attributes and a target price at which that “bundle of attributes” which constitute the product or service will sell.

The firm must next test out whether it is capable of delivering that product at the target price. In order to do that it must specify the exact value chain for providing each of the product characteristics. This will involve specifying how the firm’s inbound logistics, operating production procedures, outbound logistics, distribution system and after-sales service all impact upon the proposed product attributes. If current elements of the
value chain cannot deliver the product attributes, the firm has to decide whether it was being too ambitious and settle for a more easily attainable set of product attributes (provided that it can still be sold) or set about improving the relevant aspects of its value chain. If it takes the latter route, it will be necessary to establish exactly what the value chain modification will cost and whether that still feasible within the target price. Of course, as explained above the target price itself is a product attribute and the firm may discover that it can produce the non-price attributes with its current practices and resources, but not within that price. Either way attention will need to be focused upon cost reduction in order to achieve the non-price attributes within the target price (cost) or a functional cost analysis in order to establish which attributes can best be downgraded to produce the minimum reduction in market attractiveness of the product for the maximum reduction in cost.

It is likely that several iterations around this process using Functional Cost Analysis and Value Engineering will be needed before a desirable mix of product attributes and target price can be delivered, namely a mix which is attractive to the buying market and the producer/seller. Once this desirable mix has been established as a feasible proposition, the producer can ahead and invest or accept the contract. The whole system is mapped out in Figure 2.

It should now be clear how all the new developments described above could fit into such an overall process. Careful cost behaviour analysis and cost driver identification will be needed to cost out proposed changes in the value chain and the product attributes derived from the Functional cost analysis and Value Engineering - this suggests a role for world class finance functions using ABC principles. Cost reduction may be pursued by trying to squeeze out waste using a COQ approach. The TOC method might be used to identify constraints which prevent cost reduction attribute improvement. The important point to note is that whatever mix of tools is used in such a process, all the cost calculations will be made prior to the acceptance of the project or investment decision. This implies that such an approach is best employed where a firm is planning a succession of product developments. The next generation of products to be launched should be nearing the end of this process, the generation planned after that will still be in the earlier stages of this process.

Where this approach can be implemented successfully, it should be possible to simplify the accounting processes required to monitor performance. The cost analysis will have been conducted rigorously beforehand and operating control should be attainable by reference to broader aggregates provided that managers keep to their agreed planned way of operating. This has some similarity with the philosophy behind Goldratt’s TOC although it is not identical to it.
Figure 2 A Schematic formal Analysis for Strategic Investment Decisions
Balanced Scorecards

Another recent development has been balanced scorecards (see particularly Kaplan and Norton, 1996). The thrust behind this development came from a dissatisfaction with reliance on just financial statements, especially the Income Statement and Balance Sheet, as the dominant means of checking a corporate group or division’s position. Initially, in 1992, Kaplan and Norton proposed that was a need for ‘balanced scorecards’ which reported performance along four different dimensions: a financial perspective, a customer perspective, an internal business perspective and an innovation and learning perspective.

An example was shown based upon a particular company which illustrated how various indicators would reveal performance in these different dimensions which would give a better indication of the company’s ability to perform in future. An outline of this company’s system is shown in Figure 3.

This was a step forward in moving the focus of attention in performance monitoring beyond financial analysis, but it could still be criticised in that it did not offer a clear way to decide what was important to measure and what not. There seemed to be no serious attempt to develop a clear theory of success for each company or division which would serve as the basis for choosing between many possible indicators and dimensions which could be measured. Without such a theory, how could the performance monitoring be balanced - i.e. how would one know what weight to put on some factors compared to others? Perhaps it was always implicit that these factors would be based on the key result areas and key success factors appropriate to each corporate unit being monitored. It certainly has now been set out very clearly in Kaplan and Norton (1996) where a whole book is devoted to linking up these ‘scorecards’ to the firm’s specific strategy and key success factors. In fact Kaplan and Norton (1996) now say, up front:

“A properly constructed Balanced Scorecard articulates the theory of the business.”

This scorecard will set out clearly the cause and effect relationships assumed to underlay the firm’s strategy and be used in more innovative companies as the basis for a complete management system and not just a measurement system.

As it has evolved, the Balanced Scorecard has now much in common with the model described in section VII and outlined in Figure 2. Indeed, the two approaches should be integrated. What is not clear is how detailed the balanced scorecard ex-post monitoring needs to be if a company is project based and undertakes its pre-planning well. Performance against broad milestones may be sufficient. The balance between ex-ante planning and ex-post reporting and by implication improvement while the project is underway rather than beforehand will probably need to vary from firm to firm and industry to industry.
Figure 3 ILLUSTRATION OF A BALANCED SCORECARD

<table>
<thead>
<tr>
<th><strong>FINANCIAL</strong></th>
<th><strong>PERSPECTIVE</strong></th>
<th><strong>GOALS</strong></th>
<th><strong>MEASURES</strong></th>
<th><strong>CUSTOMER</strong></th>
<th><strong>PERSPECTIVE</strong></th>
<th><strong>GOALS</strong></th>
<th><strong>MEASURES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Survive</td>
<td>Cash flow</td>
<td>New products</td>
<td>Percent of sales from new products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Succeed</td>
<td>Quarterly sales growth and operating income by division</td>
<td>New products</td>
<td>Percent of sales from proprietary products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prosper</td>
<td>Increased market share and ROE</td>
<td>Responsive supply</td>
<td>On-time delivery (defined by customer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INNOVATION AND LEARNING**

<table>
<thead>
<tr>
<th><strong>GOALS</strong></th>
<th><strong>MEASURES</strong></th>
<th><strong>Tech</strong></th>
<th><strong>GOALS</strong></th>
<th><strong>MEASURES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological capability</td>
<td>Manufacturing geometry vs. Competition</td>
<td>Technology leadership</td>
<td>Time to generate next generation</td>
<td></td>
</tr>
<tr>
<td>Manufacturing excellence</td>
<td>Cycle time Unit cost Yield</td>
<td>Manufacturing learning</td>
<td>Process time to maturity</td>
<td></td>
</tr>
<tr>
<td>Design productivity</td>
<td>Silicon efficiency Engineering efficiency</td>
<td>Product focus</td>
<td>Percent of products that equal 80% sales</td>
<td></td>
</tr>
<tr>
<td>New product introduction</td>
<td>Actual introduction schedule vs. plan</td>
<td>Time to market</td>
<td>New product introduction vs. Competition</td>
<td></td>
</tr>
</tbody>
</table>

The developments in cost management described above have been developed largely in manufacturing industry. It must not, therefore, be thought that they can be transferred with immediate success to the construction industry - especially to the civil engineering side of this industry which is where the Agile project is focusing at present. It will be instructive, therefore, to set out the very basic components of management accounting/ cost management as traditionally applied in this industry before proceeding to consider what might be desirable in future.

The tradition has been for those requiring the construction of major civil engineering works to issue specifications of major projects to be undertaken and invite competitive bids to undertake that work. Competing civil engineering firms then clearly need to undertake their own estimating process before deciding what bidding strategy to employ. As Smith (1995) explains, the process of estimating is an essentially linear procedure: costs of all direct inputs to the scheme are estimated and additions are then made for overheads and profit. It would appear that this initial estimate should be of vital importance if the civil engineering firm is to avoid losses. Moreover, if the firm wins the bid, it seems logical that this estimate should become the budget for the construction scheme.

Initial general enquiries within Balfour Beatty indicated that things do not always run as smoothly as this in real world processes and this finds strong support in existing literature. Smith (1995) says that it would seem appropriate for construction companies to base their estimates upon costs that they know they can keep within as based upon records of costs on previous tasks, but he continues to stress that, in practice, estimating has not been a precise process and much subjectivity is involved. Smith supports this statement by referring to several others with similar views. Ashworth and Skitmore are quoted as follows:

"Estimators' standard outputs are contained and secretly guarded in their 'black books'. They are only rarely ever amended or revised . . . A major reason given why estimators disassociate themselves from site feedback is due to the poor recording systems employed by contractors and hence lack of confidence in the data provided." (Ashworth and Skitmore as quoted in Smith, 1995)

Smith also quotes others like Fine (1974) who likens estimating to witchcraft and Adrian (1982) who is more restrained, but still views estimating as more art than science.

Some support for Adrian’s position (though probably not Fine’s) was obtained from initial enquiries within Balfour Beatty where it seems that the tenders are prepared on the basis of standard productivity assumptions which are translated into the form of bills of quantities, but there is no easy way of checking these assumed productivities.
against actual productivities at a detailed level. The operating accounts for projects report variances in spending terms, which is valuable for placing an emphasis on budget responsibility, but do not report productivity variances. Control over projects through accounting generally focuses on three concepts of cost which are tracked through the life of each project: Budgeted Cost of Work Planned (BCWP), Budgeted Cost of Work Completed (BCWC) and Actual Cost of Work Completed (ACWC). The difference between the accumulated costs BCWC and ACWC represent the current overspend or underspend situation. It was stated that some sites may split the overspend variances between price and productivity variances, with a waste variance as a subset of the latter, but this is not a general company practice.

Initial casual evidence suggested, therefore, that, as Smith says, there is a lack of sufficient articulation between the estimating basis and the planning and control basis and that the source of this inconsistency lies within the accounting structure, but it must not be overlooked that other factors such as:

i. the very limited time normally available to submit a bid

ii. the need to win the bid in a highly competitive market, perhaps by submitting bids at prices which are barely achievable in cost terms on the expectation that profits can be made on additional work that is discovered to be necessary after the project has started and

iii. the perceived necessity to ease cash flow by front-end loading of costs

also have some influence upon the degree to which actual historic costs tie in with activity costs assumed when bidding for new business. Of course, low price bidding to get the contract together with reliance on subsequent “extras” to provide profits, may not arise only at the total contract level. The same “game” may be played on main contractors by sub-contractors. In fact a senior manager in Balfour Beatty has suggested that there is the suspicion that, at all levels, one might find a correlation between the acceptance of low price bids and subsequent higher actual costs and, in his view, this issue would warrant research.

The essential nature of financial operations in civil engineering are, therefore, quite straightforward. Construction companies respond to specifications, and often bills of quantities, supplied by would-be customers. An effective basis of estimating is needed to avoid submitting tenders at unrealistic costs which would leave the contractor exposed to loss. The inherent nature of much civil engineering activity is uncertain and so a systematic procedure for assessing risks should be integrated into the tender estimates and then, if the bid is successful, operational controls should be devised to control progress in the project against cost and accomplishment (the latter to take into account the different activities involved in the whole project and the time allowances in the plan to achieve them). Bearing in mind that there is always some sequencing

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3 Some managers in Balfour Beatty stated that, while it is true that the company does not have good feedback between actual costs and bidding estimates, design and construct contracts have shown actual costs close to those budgeted. The important question is, however, whether the appropriate costs for required functional specifications are incorporated into the initial budgets in the first place. Actual costs probably have to made to comply with budgets at a macro level or the company will soon be in financial difficulty, a relevant question is what actions are taken in order to do that if the initial estimate was wrongly based and are such actions dysfunctional? To gain better insights into this, it would be useful to test agreement between budgets and actual costs at more detailed levels both for design and construct and for traditional re-measure contracts.
required of activities, additional control over planned completion of the project is
required in the form of a network model such as critical path analysis. It would appear
that these requirements ought to be fairly easy to satisfy. More effort seems to be
necessary, however, in undertaking more detailed analysis of the costs of construction
activities in order to identify cost reduction possibilities and feed this information into
the process of competitive bidding. A more accurate knowledge of activity costs could
even be seen as a source of competitive advantage.

Two recent developments need to be considered which add some complexity to the
brief outline just given. Increasingly, civil engineering projects are being let on a
design, build, finance and operate basis (DBFO). This means that no longer do clients
prescribe in some detail the specification of the structure to be delivered. The client
under DBFO contracts is more interested in the services which the contractor will
deliver from his structure over a period of years where the contractor (or a collaborator
in a consortium of which the contractor is part) takes a much longer time interest in the
asset by agreeing to operate it to provide those services. The complications deriving
from this form of contract are essentially twofold.

First, the contractor now becomes much more heavily involved in the design process.
This means that he gets involved at a much earlier stage when it is impossible to make
very precise estimates. The cost estimates and, therefore, the contractual terms have to
be developed as the design takes place. At the same time, the old cost-plus type of
contract is abandoned and replaced by a fixed price contract (perhaps modified by
incentive factors as discussed shortly below). This means that the contractor has to be
more thorough in estimating costs.

In fact, Balfour Beatty still operates at arms length from their main client, The
Highways Agency, and the contractor’s immediate client is the concession company
(Connect) which deals directly with the main client and has responsibility for
delivering the whole completed project to the client. Even so, the fact that the
concession company is now involved in the design process means that it must also
involve the main contractor, and perhaps in due course the main sub-contractors, in the
consideration of alternative designs and costs. This suggests that the contractor’s
estimators will have to structure their estimates more around the functional attributes
of the project (and alternate functional attributes to facilitate choice in the design
process) and it may become less satisfactory to rely on previous broad standards. This
also suggests that contractors will need to be more aware of the likelihood of long term
warranty costs and more thorough in assessing life cycle costs. With large long life
civil engineering projects it is likely to be problematic to make accurate long run
predictions of some operating costs.

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4 This is not meant to imply that project management should necessarily be highly centralised during its construction stage. Parts of the
project may well be given to quasi-autonomous groups whose leader is expected to deliver defined outputs at a cost by a due date and
do whatever is needed to achieve that. But all project will require some degree of sequential planning before such responsibilities are
assigned.
5 In general the materials costs are well established, more accuracy is required in determining activity costs associated with throughput
and the cost of current waste in terms of non-value added activities.
6 Whereas the long term risks for the contractor will be the risk that projects will not deliver services specified long term or at the
operating costs agreed, the concession company’s main risk will be the continuity of income from the scheme (e.g. toll income in the
case of roads and bridges).
If closer supply chain relationships develop in order to seek continual improvements in practice, it will also become important for all main parties in the supply chain to have access to each other’s cost records and understand each other’s costing system to ensure that prices for functional variations are fair. Indeed, it would be in Balfour Beatty’s interest now to work closer with its own sub-contractors to examine their cost structures and costing methods.

Another clear difference in the employment of this Target costing approach in civil engineering (compared to manufacturing) is the need to consider how such an approach should be reflected in the financial incentives and penalties incorporated into the contracts. In most of the manufacturing industry in which Target costing has been applied, it is not necessary to address this problem because sales are direct to the public and rewards and penalties are based on success in the market place in terms of volume and value of goods sold. If target pricing and costing (including value engineering and functional cost analysis) is to be applied in major civil engineering projects, as stated above it will be necessary for the client, the concessionary company, contractor(s) and main sub-contractors to work closely together to manage cost down without prejudicing functionality and quality. The question then must arise as to how it will be fair to divide the gains achieved between the client and different parties in the supply chain. The new emphasis on DBFO contracts will need a new emphasis on the types of incentives that encourage the contractor and sub-contractors to reduce cost as much below current bench-marked best practice as possible (consistent always with achieving functionality, safety and quality in both construction and life-long service). The incentives will need to guarantee a reduced maximum price below the currently best achievable price at the same time as motivating the contractor to be serious in engaging in planning to reduce planned cost through target costing and also then try to achieve further savings from planned cost in implementing the design and, where appropriate, operating the service. The basis for such “multi-faceted” financial incentive schemes already exist, but they tend to have been disregarded while competitive bidding was the vogue in the belief that such a bidding process ensured sufficient pressure to reduce cost. The emergence of more DBFO work will necessitate a reconsideration of financial incentives that have all the various attributes listed above.

The second major change on the industry over the last decade has been the cut back in orders and the extreme nature of competition in the industry. Industry demand and profitability has been low, margins have had to be cut and go on being cut. Survival in such an environment requires continuing improvement. This can take the form of new materials, new technical procedures, new procurement processes or new management processes and preferably some combination of all four. At least, now that construction firms are more involved in the design process, they should have more scope for seeking improvements in cost reductions or improved timeliness or functionality. The major part of costs are determined at the design stage; it is at that stage that alternatives can be explored to achieve an acceptable cost. Under the previous regime of building to given specifications, the scope for improvement could come only from improved construction processes and the choice of alternates there was severely constrained by the project specification. The increasing competitive pressure therefore also suggests that more emphasis in the total planning and control system must be placed on the design stage. This will not, however, be sufficient. Further improvements in
operational procedures will be needed which lead to lean forms of operation where lean means being able to deliver the asset with the minimum of resources.

On the basis of the description of new management accounting developments above and the nature of contracting in this industry, it is now possible to attempt the construction of a normative framework for planning and control for civil engineering projects. It seems obvious that this normative framework must be based around individual projects. In developing this framework it must also be noted that the structure of the financial and operating controls should follow the logic of the business processes that need to be controlled.

An attempt to provide a normative framework is presented in Table I. Essentially it draws heavily upon the strategic management accounting structure of Figure 2, but relates it specifically to civil engineering projects. It must be stressed, however, that the purpose of developing this framework in this working paper, is to draw up a template against which to compare and contrast in some detail the system currently operating within Balfour Beatty and elsewhere in the industry. In doing that we may well find that practices diverge from that suggested in our framework and for good reason, but the framework will provide a map to help us find our way through the planning and control systems. If we just look without such a map we may not appreciate what we are seeing. Armed with a map of what we would expect, the difference will become more apparent and justifications sought or change suggested. We stress, therefore, that this framework is still very tentative. It is also still only in outline form. But as we travel aided by the map we shall be able to fill in much more detail in an attempt to reach our goal of providing a more complete guide for the industry. To conclude this paper, we now describe this control framework and indicate where in particular further research needs to be undertaken to test out whether and if so, how, in some detail, management processes should be undertaken to support it if they are to be able to claim the tag of being world class.

Table I divides the total framework into three sections. In practice it may be relevant to use more general stages, but the principles should be clear from using just these three. There is an initial stage which leads up to the agreement over the main conceptual design. This section is new following the introduction of DBFO contracts. The second stage then follows through the analysis and planning required to move from concept to the commencement of construction. The third stage deals with control activities during construction and for the subsequent operating stage in which services are delivered from the asset. It is clear that as one moves from stage to stage, the flexibility to change plans decreases.

At the beginning of the Concept Development Stage an initial functional specification must be developed based upon the service attributes that the customer requires from the asset. This specification will take into account the activities required to create an asset which delivers those attributes. Clearly, practical feasibility must be considered, especially in relation to what rival firms can deliver. While only expressed in three lines in the Table, it is essential that these steps are planned very carefully - the previous rush to tender in four to six weeks must be come a thing of the past under these new arrangements. One of the main points in moving to a DBFO approach is to take time in collaboration over the design. If the base specification and initial costs are
not based on sound estimates of costs and, perhaps benchmarked against best practice, the subsequent analysis will be far less meaningful.

On the other hand, current practice on DBFO contracts has not removed all elements of competition. The concession company may reduce the degree of competition such that just two or three companies are “pre-qualified” to bid, but there will still be competitive bidding involved. Public procurement rules also stipulate a minimum degree of competition. Moreover, the concession company may well “cherry pick” ideas from the unsuccessful bidders for use in the successful contract design. Hence, the contractor cannot from the outset assume a cosy relationship with the concession company and expend unlimited time and resources to get the design and projected cost right.

At this stage too, it will be appropriate to identify the major uncertainties in the project and construct a risk simulation model. This model should show how cost, time and accomplishment is likely to be affected by underlying events. The risk analysis should not be content to identify possible variability - it should also consider how to manage key risks. A standard risk matrix which shows major uncertainties plotted against likelihood and impact will be valuable in indicating where risk management should focus. Risk management might involve changing the specification, insuring against risk, subcontracting that element of the project, etc. Factors which indicate, at the earliest possible time, whether the key risks faced are going to occur, should be identified and introduced into the management monitoring system so that contingency plans can be activated if necessary. This information will also be very relevant to consider when establishing the Theory of Constraints buffer system (see below) if it is to be used to manage risks and progress once the construction has begun. Little of this is conventional accounting, but it is a vital financial management function under the DBFO regime. In any case, as Johnson (1988) argues, to be successful in world class operations the emphasis must move from traditional cost accounting to focus on the control over activities - non-value activities must be identified and removed; value added activities must be improved.

A careful identification of necessary, value-adding activities together with careful bench-marking of costs will lead to the first cost estimate. We are aware that conventional texts on estimating for construction (e.g. Smith, 1995) distinguish between Unit rate estimating and Operational estimating (including Method-related charges), and we feel that a move to estimating based on identification of operations is probably needed to provide a more direct link between project design and planning and the subsequent on-going control during construction which should be activity based. However, it is not necessary to be categoric at this stage of our research. One needs a basis which best allows a rigorous basis for estimating costs whatever it is, but then, if it is not activity based, it must be “cross-walked” to an activity classification at least at high levels of activity to enable subsequent implementation to be monitored.

One other point on cost estimating needs emphasis. The cost estimation should be based upon a clear understanding of how the functional attributes of the project influence total project cost. To do this it is necessary to understand how the delivery of functional attributes require different activities and how costs vary according to activities undertaken. This suggests a need for Activity Based Costing with its careful
assessment of cost drivers for different cost pools. In this case ABC principles would be employed *before the event* and not just used to identify costs of existing operations. ABC focuses on the identification of how overhead costs are driven.

It may be thought that there will be less call for ABC systems in civil engineering because of the way work is structured into projects. There are broadly three levels of work: work on site (which may well be divided into different sections of sites), work at site offices and work at corporate headquarters. In Balfour Beatty no corporate headquarters overhead is allocated to site offices or projects. Site office overheads are, however, allocated to projects, but not usually to sub-sections of projects. In all probability this does not cause much cost bias in keeping track of the total cost of the project (or sub-project) as it is being built as the majority of costs for projects and sub-sections of projects can be traced directly. But the need for knowledge of the total cost of a project or sub-project during construction, must not be confused with what is needed at the design stage. At the construction phase it may be satisfactory to operate as though the whole project or significant parts of it are the costing units for monitoring purposes, but at the design stage the full cost of the possible variations in functional attributes must be identified and it may need some effort and skill to sort out the costs which are generated by variations in the functional attribute by reference to the underlying activities which deliver those attributes. The extent to which ABC thinking needs to be integrated by accountants into this process in the construction industry is not clear. Perhaps existing practice already approximates what is required, but the casual evidence presented above suggests that this may not be so and that there is an inadequate link between the basis of estimating used and the costs actually experienced. There seems to be a need for this to be tested out in this research.

Also, as previously described, Functional Cost Analysis breaks down the asset into its constituent functions and check whether the relative emphasis put upon each function by the client (or in-house staff playing the role of the client) is roughly matched by the relative costs of supplying each function in the project. While it is clear that a Functional Cost Analysis might always be applicable for the construction of buildings, it is not clear whether it has such a large potential role with regard to civil engineering works like roads, bridges or tunnels which are the types of schemes that we are most interested in at present. The variety of possible choice of sets of functional attributes may be much more limited in the construction of roads, tunnels and bridges. Nevertheless, this should not be assumed; it needs to be checked out and, if it transpires that there is a significant role for FCA, there is likely to the need for a capable accounting input to that process. In addition, our theorising may be somewhat ahead of developing practice.

It has been stated by a senior person in Balfour Beatty that DBFO is still at the stage where it is just an exercise to get a road or tunnel development on "hire purchase" and that companies are still a long way short of a full implementation of target costing as described in this paper. This may be so, but our study is trying to see how the industry must develop to become world-class and this is the direction in which it seems likely that practice will develop and construction firms should be addressing such issues. Furthermore, one of the authors has been associated with construction developments

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7 Functional attributes for a road surface, for example, might include noise, speed possible in different weather conditions, aesthetics, long run life cycle costs.
involving two different companies where a direct target costing and value engineering approach is being used with close collaboration between client and contractors and a target costing approach has been used by Balfour Beatty for some smaller projects and it would be valuable to study these projects to see how they compare with the theoretical ideal of target costing as described in textbooks.

Even so, it is possible that there will be more mileage to be gained in the immediate future in identifying more accurately the direct costs of individual activities in the construction process and use those to assess the reliability of estimates made in the bidding process, rather than worry too much about the allocation of site office and, especially, head office costs. In fact developments occurring within Balfour Beatty are more concerned with the identification of these direct activity costs and so a newcomer to this company (and industry) needs to beware that when he or she hears reference to activity based costing, it rarely refers to ABC as described at the outset of this paper. But the extent to which ABC overhead allocation methods are needed will depend upon how refined an activity costing is required. The more one moves down the operational hierarchy to define activity costs of construction in more detail, i.e. to discover the cost of activities defined at a more detailed level, the more it is likely that better methods will be needed for allocating costs that are perceived as being overheads at that more detailed level of analysis. While most costs may seem to be direct at the project or major sub-project level, this will not necessarily apply at a more detailed level of activity.

Moreover, the aim of target costing is not just to prepare a sound basis for cost estimation. This is important, but there is more to it as already described above. Having arrived at a first estimate, it is in the contractor’s interest to search for ways of improving the design to manage the cost down without losing time or reducing functionality or vice versa. This will be because the initial cost is above the price that the client is willing to pay or because the contractor needs to continually improve to maintain a foothold in the market. The two principal tools developed in the motor industry for doing this are Functional Cost Analysis (FCA), as just discussed, and Value Engineering. Even if the role of FCA proves to be limited, there will almost certainly be much scope for Value Engineering within DBFO contracts. Moreover, given that the proposed system is still being described at the Concept Development Stage, there remains scope for radical suggestions for change to the specification. Value Engineering essentially does no more than get a multi-disciplinary team to search for alternate ways of delivering the functional attributes required in the asset. Once again, VE will not be effective unless the cost implications of ideas generated are properly assessed and can feasibly be attained.

After several iterations around the Functional Cost Analysis / Value Engineering loops, a cost estimate will be arrived at which is acceptable for the establishment of the project concept. It should be quite clear that if these steps are undertaken rigorously,

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8 Site costs are of the order of 12 - 15% of contract price and head office costs about 3 - 4% of gross revenue. At the bidding stage, estimators' decisions on how to allocate these oncosts are driven more by the need to front-load costs to get earlier cash flow from the client or to make more money out of remeasure when they know that more inputs will be required than indicated in the tender and reimbursement for the extra input will be made including the oncost rate for that activity included in the bid. Hence, oncost allocation is seen more as a means of increasing profit than an attempt to see what actually drives the oncosts themselves. For some contracts, however, oncosts are reassigned afterwards for cost monitoring purposes.

9 It is interesting to consider, how the process of radical innovation within the design of a specific projects has to be balanced with a more centralised and on-going R&D activity. How this is best managed is another useful dimension worth research.
one will have a much firmer estimate of costs than seems currently to exist for many projects as evidenced by the brief references to literature above. Moreover, and it cannot be over-estimated, it will be activity based. With such an estimate, one can move forward to the next stage with a settled concept design which should be feasible in terms of cost, time and functionality. There is still, however, a lot to be done before construction can commence.

From this discussion of DBFO, one expects the development of much more co-operation between the contractor and client in considering alternate ways of delivering the service required within a projected cost that the client can meet. In due course this may develop into offering the client a choice from several combinations of standard options. Balfour Beatty suggests, however, that the industry is still a long way from achieving close collaboration in design in this form all the way down the supply chain from client to sub-contractor. At present significant contingency allowances are used to protect against risk and any move in the direction of more rigorous costing in design and of alternate design packages will probably proceed on an “80/20 basis”.

Moreover, it was stressed that under current practice there simply is not the time for extensive consideration of re-engineering with regard to each separate project, but that there is, nevertheless, something that can be learned from the target costing / strategic management model.

Pending a wider modification of bidding practice and closer collaboration with concessionary companies and clients, it was suggested that there should be a central function which is thinking ahead to identify the alternate standard components of design packages which have different functional attributes and a differential call on financial resources, work force skills, etc. The question then arises as to where in the organisation is this thinking taking place? Who is identifying the different standard components of schemes that can be offered to customers? Who is linking this to the company’s R&D activity and recruitment processes? Who is trying to match the development of such standard design components with developing customer requirements? How should all this be organised? There should presumably be collaboration in such a task between market research and engineering, but how well is this carried out at present? In other words, even in the interim before closer collaboration is developed along the whole supply chain, the company should still be using a model like Figure 2 to develop standard design components from which the client and concessionary company can select an appropriate mix. One can argue further that thought at corporate level guided by Figure 2 should help to reveal the company’s desired strategy for the foreseeable future which can then be distilled into the necessary key success factors which can be monitored along Balanced scorecard lines. Hence, while this paper focuses mainly on project development and control, it also has some implications for accounting at the broader corporate level. In fact Balfour Beatty’s parent, BICC, has already conducted work in this area, but the approach is far from well developed in the industry and further research here would be warranted, but let’s get the argument back to Table I.

**Stage II, the Planning Stage**, relates to all the pre-construction planning that is needed. This will involve setting out work plans, arranging procurement, planning for resources, etc., etc. This has not been shown on the Table as it is largely beyond
accounting. Accounting still has, however, a role during this stage. As well as assembling more detailed costs, there is still the opportunity as one looks at each activity (operation) in more detail to further improve the cost/time-functionality ratio. Now that the basic design is settled, there will not be such scope for radical change, but improvements will still be possible. It is also possible that ideas for more radical improvements will be identified which, while too late for this project, may be carried forward for future use. There may also, therefore, also be a “cost management loop” in this Planning Stage of the project. It is likely to have two dimensions: one concerned with supply management and one concerned with second phase (and more restricted) Value Engineering. Once more, it is important to have the accountant involved to check that savings claimed from modifications are consistent with knowledge of activity cost drivers. In addition, if the civil engineering industry moves in the direction of closer relations with preferred suppliers, the accounting function will need to be involved in both the selection and work with those suppliers - perhaps through open book arrangements. (Key suppliers may also play a part at the design stage and so cost behaviour will need to be traced through their operations too). Eventually, the end point of this Stage should be an agreed target cost which is now specified in much more detail, which meets the desired level with an acceptable degree of risk and can be directly linked with control over activities as construction takes place.

The Third Stage in Table I takes us through to the Construction Stage. The whole emphasis of this paper has been that the accounting analysis of a world class finance function must directly serve the operating and decision process of the company. Having designed and planned the project and its associated costs, the next stage is to organise and plan the operational procedures particularly relating to the risk management process.

The authors have been impressed with the steps taken in Balfour Beatty in implementing a variation of the Theory of Constraints developed for application to large scale projects. The essential feature of this TOC approach is to manage centrally the whole project risk associated with completion time. This involves setting a time buffer to be used by the project director as he sees fit during the construction process. The means that each person responsible for a section of work is not given an early and late finish time as might be done from the project Critical Path Analysis, but is given a clear start and finish time. Where delays occur, only the project director can modify subsequent stages by use of the centrally held time buffer. This overcomes the problem which sometimes arises when managers of sub-sections of the project have non-critical path activities with known time floats which are then used up at local discretion such that most of the network becomes a very tightly scheduled critical path - the consequence is that any subsequent delay anywhere in the project delays the whole project.

Similar buffers are set for separate sequences of paths which are not themselves critical, but which fed into the critical path. A time buffer will be created for the total string of those activities at the point where the string joins with the critical path, rather than distributing floats to all activities in the string.

This approach has clearly been developed from TOC principles. The founding principle of TOC was to look at the production, here construction, problem
holistically. The overall goal must always be borne in mind and decisions taken which are consistent with the goal. Moreover, time is not the only risk dimension to be managed - risk management of time needs to be integrated with risk management of cost and functional achievement. It is clear that the authors feel that there is much to be said for a central approach to project risk management and this, almost paradoxically, goes hand in hand with giving more discretion to teams to manage their own activities within the project. An example of this approach was observed being used successfully in Balfour Beatty and will be outlined below.

With the operational procedures planned, the next stage is to decide at what levels the three prime control factors for each project (time, cost and accomplishment) will be best measured. All of the detailed cost analysis developed in the design and planning stage does not need to be employed in monitoring progress. Sufficient is needed just to ensure that progress is being made according to the plan and that it will be possible to drill down for root causes if and only where progress falters. This will also involve looking carefully at managerial responsibilities at each level to see how they will be monitored. This minimalist monitoring approach will only be possible, however, if the original design and plans were drawn up with rigorously prepared cost estimates. If they were not, there will be significant deviations from plan in many areas of the project and a more elaborate accounting / information system will be needed to unravel all the deviations.

There is a qualification to this suggestion of minimalist operating financial data. It has been argued that cost estimates in the design stage should be based on levels of productivity that the company knows that it can deliver for different activities. It is obvious that some measurement of productivity and cost performance at the more detailed level will be necessary to serve as the basis for verifying future bids, but is that not inconsistent with the minimalist financial control suggested above? We think that it may not be - the company needs to know the levels of productivity that it can deliver, not the productivity actually achieved on every project in every activity. It may then be possible to monitor current levels of productivity achievable at just one or two best practice test sites to feed into the design debate.

With the operational processes and responsibilities clearly allocated, it will then be possible to set measures to monitor progress at the key points of the project. This will, obviously have accumulating cost, time and aggregate accomplishment features (probably with variances of planned and actual cost against, separately, time taken and accomplishment achieved; variances of planned and actual time against, separately, cost and accomplishment; and similarly for accomplishment), but may well also have non-financial measures formulated along the lines of the Balanced Scorecard ideas. It will be appropriate at this stage too to consider whether to introduce an incentive/penalty for early/late completion into operating cost statements (see Tomkins, 1997). At that time also, it will become clear how far it is necessary to allocate overheads - in all probability it will not be necessary to develop an extensive overhead allocation system (ABC or otherwise) for costing projects and their phases (as distinct from attributes and their detailed activities at the design stage). As stated earlier, it should be possible to trace most costs direct to projects and project segments or phases. Where control is thought to be desirable over critical activities, it can
probably be done by means of physical measures or costs variable to that activity. But remember this is only speculative - the matter needs to be researched.

Whatever cost or other measures and incentives / penalty charges it is decided to use, care must be taken to bear in mind Goldratt’s message from *The Goal*. The objective of the whole enterprise is to complete the project on time (or early), to budget and with no defects. That is the goal and local measures of performance must not operate in such a way that local optimisation to these measures prejudices achievement of that goal. In a very large project this may not be easy to achieve. Large projects have many facets and the only way for the project director to keep a view over the entire project is probably by means of these measures - hence he / she cannot be aware when action is being taken to look good on these local measures despite their effect on the goal.

One approach, already employed in some Balfour Beatty projects, is to ‘divisionalise’ the project into separate sections of the project (rather than functional specialisms10), with each section, or division, having its own total time and cost budget to manage itself. This meant, on this project, that overheads had to be charged out to phases of the project and not left at project level.

This approach to segmenting the project for management purposes is similar to divisionalising a company, rather than having all functions reporting to the centre.11 The Balfour Beatty site which impressed us with the use of the TOC risk buffers (see above) divisionalised a major road project in this way in order to gain the behavioural benefits of having local teams for whole segments of the task who then identified with the success of that segment, but then introduced TOC as a means of maintaining overall co-ordination without destroying the notion of delegated responsibility12. The combination of delegation with overall control by TOC provided tighter control from above on completion times, but then allowed more local discretion as to how this was to be achieved. Such an approach which aims to profit by emphasising the idea of team work, co-ordination and problem sharing at lower levels in the project organisation may help to soften the dysfunctional effect of local measures. The approach is not a panacea, however, if such an approach is to be used there are still issues to be faced in terms of how the centre will relate to the project divisions. Will the centre now simply be advisory? If its completion targets are not met how will it decide when to intervene? What information does it want from the division and how will that vary with the type of central role to be played? These are all issues which have to be addressed as alternate ways of managing projects are considered.

Where financial control through accounting records is required over separate project phases and activities, an important issue which will need to be addressed is how to...
handle joint activity costs\textsuperscript{13}. A significant element of direct construction costs are plant costs\textsuperscript{14}. A problem may arise as to how to charge out plant to different parts of the project or even different projects - especially if plant is left idle for any significant amount of time. The problem may not be so severe where plant is leased on a short-term basis for specific tasks - the direct costs should then be clearly traceable. Even, however, where plant is leased, it is possible to leave it idle. A partial answer may be to set up plant hire, whether self-owned of long-leased, as a cost or profit centre in its own right. Plant would then be charged out on a per day basis, perhaps at market price or at a price to cover the full capacity costs. Then activity managers would very conscious of the cost of extra days usage of that plant and between them have to pay for idle time which in turn should encourage them to object strongly when costs increased through overall use of the plant at a level somewhat less than full capacity. The Plant Cost / Profit centre manager would be responsible for seeing that he / she did not hold excessive plant “in stock”. It was stressed that this was not a major problem in Balfour Beatty but it did need to be borne in mind. It was also pointed out that a TOC approach to time management would enable criteria to be set for deciding who used shared items of plant first (but a conventional critical path analysis could also accomplish the same thing).

Whereas we felt that we could be more definitive in stating what the world class finance function should be doing in design and pre-construction planning in civil engineering (although we stressed that it all needed putting to empirical test), we are really only able to identify issues that need to be addressed when we contemplate control over the construction activity. This may seem strange, when this has been the focus of control by finance functions in the past such that one might think that they would have little to learn in this part of the control system. That may prove to be so, but the advent of DBFO contracts and the more intense attention that will have to paid to cost at the design stage, may provide the opportunity to reduce the amount of operational accounting undertaken. Only a careful consideration of practices with regard to the issues raised here in the light of the way design and planning practices change will answer this question.

This is still not, however, the end, of our template for the design of a top class financial control function. There are still two dimensions that the system designer needs to consider. Is all thought about improvement to be left to the design and pre-construction planning stage or will the company want to support a continuing learning and improvement process. If a company is starting off from a relatively inefficient position, it may well wish to employ a COQ or TOC methodology followed by root cause analysis. These are techniques which offer the prospect of significant improvements if they have not been used before. If, on the other hand, the company is already quite ‘lean’, a Kaizen approach, which seeks continuing incremental improvements through shared learning at local levels, may have more to offer.

\textsuperscript{13} There is also a case for more careful identification of plant costs by activity if actual costs are to compared with bidding costs as argued earlier in this paper. Currently, the estimator is allowed to charge standard amounts of plant costs for given activities, but his prime task is to see that total plant costs which are likely to be incurred fall within the sum of the allowances for the activities - he is not really so concerned that individual activity plant costs are accurate. Any surplus between his estimate of total cost and the aggregate of the allowances may be viewed as allowable idle time for the plant; it would be better if accurate knowledge of activity plant costs could turn this idle time allowance into profit.

\textsuperscript{14} Direct labour costs only account for about 10% of direct construction costs.
From initial research on COQ issues in the Agile Construction Initiative, a strong case seems to be emerging that the level of non-value added work being undertaken in major projects is of a high enough order to make that a very fruitful approach at this phase of the UK civil engineering industry’s development. We are aware of arguments that suggest that the cost of tight control may, in fact, outweigh the losses due to more “chaotic” forms of project management. Our view is that such a view needs to be tested empirically and our early efforts to test this suggests that the “cost of chaos” is somewhat higher than the likely “cost of control”. In fact, it may well be in the interests of a construction company if financial control resources could be saved through less extensive monitoring procedures and diverted into the support of COQ/TOC or Kaizen as deemed relevant to each situation. Of course, the best solution is to introduce better control through processes that are themselves low cost and the approach described above which employs tight control over the overall goal together with loose control over local activities may well provide the balance between “control” and “chaos” which is needed. Our early evidence simply suggests that there is a high “cost of chaos”, but this needs to be tested out on a wider basis before firm conclusions can be drawn.

The notion of Cost of Quality investigations might also be extended into design. As contractors get drawn more into debates about design in the new DBFO environment they will be less able to cover faulty initial bidding and design by charging for “extras”, it may then be interesting to extend COQ analyses to incorporate studies on the Cost of Poor Design.

Discussion of continuing improvement within Balfour Beatty also stressed that a key problem was the efficient transfer of new knowledge across projects. The company is involved in very large road network projects in different parts of the country and with different sets of managers. Each project manager has been likened to a captain of a ship at sea without close contact with other vessels. For such a context it is important still to identify costs of poor quality and root causes, but it is equally important for this knowledge to be captured and transmitted clearly across projects if rediscovering wheels (or even failing to rediscover them) is to be prevented. If more major projects are “divisionalised” for management purposes as described above, instead of being structured around functional specialisms, there is still a need to organise co-ordination of functional specialists across projects to create the necessary learning activity.

Finally, as already stressed, DBFO brings with it a major difference in that the contractor (in Balfour Beatty’s case, it’s parent BICC) has a longer run interest in the efficient operation of the facility constructed. While life cycle cost and life cycle functionality estimates will have been made at the design stage. There will be a need to check out whether these estimates, which are notoriously difficult to make, are to be met. An accounting function somewhere needs to monitor the on-going running costs and measures will also be needed, perhaps wholly in physical terms, to ensure that functionality is being and will continue to be delivered over the projected project life. This may be more a task for BICC than Balfour Beatty.
The Target Cost Management Process

1. **CONCEPT DEVELOPMENT STAGE**

1. Develop initial functional specification

2. Identify Value Chain (necessary activities) for: i. Construction & ii. Life-Cycle Operation

3. Develop initial Cost Model (Construction costs plus present value of Life Cycle costs, plus profit element)

4. Benchmark (validate) initial Cost Estimates - consider applicability of world class benchmarking

5. Identify major Cost and Time uncertainties for individual elements of construction and life-long operation

6. Risk Simulation of Time/Cost model for construction and life-long operations

7. Set Target Cost at Expected Cost based on Benchmarks, less an agreed X%

8. Agree terms for incentives/penalties for Beating/Failing to meet Target Cost

9. *Simultaneously* embark upon Functional Cost Analysis and First Stage Value Engineering to try to reduced Benchmark cost to Target Cost in the Design and Planning stage of the construction

10. **Conceptual Design Fixed**

   *As a rough guide, at least 80% of the target reduction must be identified at this stage.*
II. **PLANNING STAGE**

11. Set Broad Cost Estimates for Construction Elements and Operations

12. Set Target Cost Reductions for each Element and set Team of Work on each Element to plan further Cost / Time Reductions with no loss of functionality by means of Second Stage Value Engineering (directed now at improving the Functional / Cost Mix of components agreed, not radical new solutions.)

<table>
<thead>
<tr>
<th>SUPPLY MANAGEMENT</th>
<th>IN-HOUSE</th>
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<tbody>
<tr>
<td>Open-book access</td>
<td>Functional cost analysis</td>
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Both supply management and in-house reviews to incorporate:

- “Virtual (or real component parts ?) tear down”
- Reviewing construction/manufacturing/delivery processes
- Reviewing cheaper components
- Reviewing alternatives materials

13. **REVISED TARGET COST**

Revised target cost within Benchmark, less x% (with agreed confidence limits) ?

- YES
- Getting Close
- NO

14. **MINI-VALUE ENGINEERING** (on small components)
III. CONSTRUCTION STAGE


16. Set Monitoring Controls for main construction activities and align with Responsibilities at each level: COST, TIME, ACCOMPLISHMENT, PRODUCTIVITY, etc.

17. Set Overhead Allocation Requirements (these may be standard for all projects)

18. Commence Construction (in fact, some pre-construction will be commenced before this stage).


20. Set Monitoring System for Appraising Life-Cycle Costs and Satisfactory functionality.

• Table 1 Target Cost Management Process
SECTION 3: CONCLUSIONS

This paper has simply reflected upon developments in management accounting in other industries and a preliminary consideration of how these might come to affect control in civil engineering firms. It is not suggested that construction has stood still while other industries have surged ahead. In fact in many ways civil engineering leads other industries where project management is concerned (see Jolivet and Navarre, 1997). It is also not suggested that the ideas and suggestions in this paper have never been tried anywhere in the construction industry. Indeed, some of the proposals we have suggested come direct from some Balfour Beatty experience. Our reflection on the developing methods has simply been used to construct a template against which to compare management and financial control practices in civil engineering. This template or map is, however, a large one and there are many places at which we could start to compare our model with practice. Moreover, the industry is only just coming to grips with DBFO contracts and so will probably not yet have adopted the approaches we suggest, particularly for design. This may also mean that making the financial control function itself more ‘lean’ in its construction monitoring procedures have to await the implementation of better design, bidding and risk planning. It does seem clear, nevertheless, that investigation is needed in a number of areas and we end with some suggestions of questions that need to be addressed:

i. What are the current costs of quality in the industry? What are their main causes and how can these costs be driven down?

ii. What costs are being incurred because of poor design? How can they be classified and reduced?

iii. What is the current depth of understanding of activity costs and are relevant cost concepts used for different decisions. What approaches are needed at operational level to improve the cost/value ratio?

iv. How can the apparently inadequate link between actual activity costs and costs used in bidding (or in finalising DBFO contracts) be improved? How necessary will it be for this to occur to competitive in future?

v. How far can civil engineering companies usefully take up target costing principles which incorporate value engineering and functional cost analysis?

vi. What degree of reliability is presently available for integrating life cycle costing projections into such analyses? Where is research needed to improve reliability of estimates? How significant will such estimates be for taking investment decisions in the new DBFO environment?

vii. Will it be feasible in civil engineering to approach target costing by offering customers choices by combining a number of standard ‘components’? If so, what types of components and where in civil engineering companies is this sort of thinking being developed?
viii. If more decentralised approaches are used for project management, what changes need to be made in the management accounting systems to support this approach to management?

ix. To what extent are currently used accounting and physical performance measures helping to reinforce or inhibit continuing improvement and ‘lean construction’?

x. What mix of financial and physical controls is required at each level of the company?

xi. How practical is it to think of complete supply chain management of cost improvement in civil engineering?

The limited number of current texts on accounting in civil engineering do not seem to address these questions. Much might be gained from examining a number of these issues rigorously in civil engineering firms. We have already made a start in the Agile Construction project on some of these topics, but the agenda of work needed is extensive and these questions will not be resolved until a number of people and companies address them.
REFERENCES

Adrian, J., *Construction estimating*, Reston, 1982


