Deterministic Management Decision Making Using Forecasting Models

Dr Farzad Khosrowshahi
Senior Lecturer, School of Construction Economics & Management
South Bank University
Wandsworth Road, London W7 1AP
Great Britain

ABSTRACT

It is widely accepted that forecasting is an activity essential to management decision making. Forecasting models are extensively used by the management to assist evaluation of project financial viability and its resulting financial commitments and capabilities. Furthermore, these models are used at the corporate level with wider implications. However, it appears that often, the forecasting models are either used as a procedural necessity without much faith in their outcome or, they are used fatalistically where the outcome is accepted on the whole.

This paper attempts to extend the boundaries of the applications of forecasting models and asserts that the pro-active management should be able to take a progressive attitude towards the concept of forecasting and exploit it as a tool for deterministic, rather than fatalistic decision and policy making.

This paper is concerned with the above notions primarily in the context of forecasting models for construction project cash flow. To this end, the paper introduces TASC - a mathematically based model - the structure and various features of which, accommodate the implementation of the above concept.

Key Words
corporate objectives; financial management; forecasting models; project cash flow; deterministic decisions;

INTRODUCTION

The construction industry is notoriously known for high level of liquidation a considerable proportion of which has been attributed to the problems associated with the lack of funds at the right time. The current economic climate has exacerbated the problem and has created additional complications. The survival of the company in the present time and the degree of its success in the post-crisis period may well depend on the adoption of a progressive and calculated policy towards financial management at both project and corporate levels.

To this end, the 'S' curve models have been generally recognised as an effective tool for forecasting project expenditure/income pattern from which project cash flow can be generated. The mathematically based models provide a simple, cheap and fast alternative to the activity/operation based forecasting models. They produce forecast at an early stage with minimum requirement for user experience and knowledge about the project.

This paper builds on the assumption that the use of forecasting models is essential to the management decision making. However, it is argued that greater performance, particularly at the corporate level, can be achieved by extending the use of forecasting models beyond that is currently being exercised. Accordingly, in this paper, TASC, is introduced as a newly developed advanced mathematically based model which facilitates such undertakings.

MODELS FOR CASH FLOW FORECASTING

On the theoretical level, there have been many models developed over the past three decades. These models have been categorised in various ways. The categories vary from activity-based vs mathematically-based models, nomothetic vs idiographic, stochastic vs deterministic, and parametric categorisation.

In practice, cash flow forecasting models have been widely used to assist construction companies to avoid costly mistakes, achieve a better capital utilisation, improve management control and to influence the confidence of the lenders. However, the majority of organisations use the non-mathematical methods. Some organisations produce forecast as a matter of procedure without due consideration to the outcome of the forecast. This is primarily due to the lack of confidence in the validity of the result. On the other hand, some organisations put too much reliance on the generated forecast, based on which, objectives are set. But this process undermines the knowledge, experience and intuition of the interested parties.

FORECASTING MODELS AS TOOLS FOR DETERMINISTIC MANAGEMENT DECISION MAKING

The state of the economy has generated a degree of conservatism among some management of the industry. Often, the tendency is to adopt a low-risk approach. This normally leads to the acceptance of risk by force, rather than its accommodation by choice.

Management decision making involves taking risks. This is a long established and exercised fact. But, what has not been fully appreciated is that if risk taking is an inherent feature of management decision making, why not take an initiative and be party in the process of the creation of risk. This facilitates a degree of control over the out come, gaining an edge over those who are likely to be taken by surprise. In order to furnish a proactive stance such as this, firstly, the state of awareness is of paramount importance, because, the management forms its decisions on the basis of the information available to him. To this end, forecasting models can play a significant role. A sophisticated model can provide a somewhat accurate account of what will happen in the future. This is why the predictive accuracy still remains as the main criteria for assessing the performance of forecasting models.

But, this is just the first step. what has been widely undermined, is essential for proactive management decision making, is the possibility of challenging what is perceived to be the future. The dependence of global objectives on the basis of what is forecasted to happen can limit the aspirations of the management in the determining and implementation of the objectives. Whereas, in the light of the opportunities and constraints, and on the basis of

company's strength and weaknesses, measures can be taken to influence the course of events in order to strike a calculated balance between what is likely and what is desired to happen.

The approach adopted for a long time, by the advertising industry can provide a tangible analogy. Normally, before a product is launched, an extensive research is carried out to improve the awareness and establish the state of what is defined as 'actual'. This will form the basis of targeting the potential users. Often, the next stage also involves identification and targeting of the semi-potential and sometimes even the non-potential users of the product through intensive advertising campaign in an attempt to massage their perception of their needs. Thus, there is an interaction between the nature of the product and the demand for it.

Therefore, proactive management should be able to take a further progressive step and utilise the forecasting model as the basis of the implementation of the desired objectives rather than tools for creating objectives. A good forecasting model will illustrate the way events are likely to happen. Thence, it should be able to assist the management to realistically determine the way it is required to happen.

TASC: THE ADVANCED 'S' CURVE

TASC is a mathematically based expenditure/income forecasting software which also generates project cash flow and a series of financial reports presented in both tabular and graphical forms. It is the product of eight years research and development. The structure and the underlying theory of TASC has been detailed by Khosrowshahi(1990). The model can generate a forecast at an early stage without the need for the expensive and tedious work involved in compiling hundreds of activities and setting their values against their respective starting time and duration. Further, it caters for updating and monitoring the progress in an arbitrary and/or regular intervals.

TASC provides the contractor and the client with information which determine the financial feasibility of the project. It will enable the user to gain an edge/advantage over the less informed competitors. The model has the following two distinctive features.

Predictive Accuracy & User Involvement

In comparison with the black box mathematical models, the activity-based models require full user involvement. TASC has a uncomplicated approach to blending the useful features of the two approaches. To generate a forecast, initially, TASC uses its database and exclusive mathematical expression to produce a forecast. Then the predictive accuracy can be elaborated through user intervention. The improved accuracy is influenced by the experience and knowledge of the user.

Deterministic Decision Making

This will be discussed in detail later.

The Structure and Facilities of TASC

The forecasting logic of TASC is based on construction of the shape of periodic expenditure pattern, which is defined in terms of its variables, listed in table(1) and shown in figure(1).

Peak Time (Xp)
Peak Value (Yp)
Expenditure Intensity
Initial Slope
End Slope
Distortions(number)
Start Point
Duration
Intensity

Table(1): Shape Variables

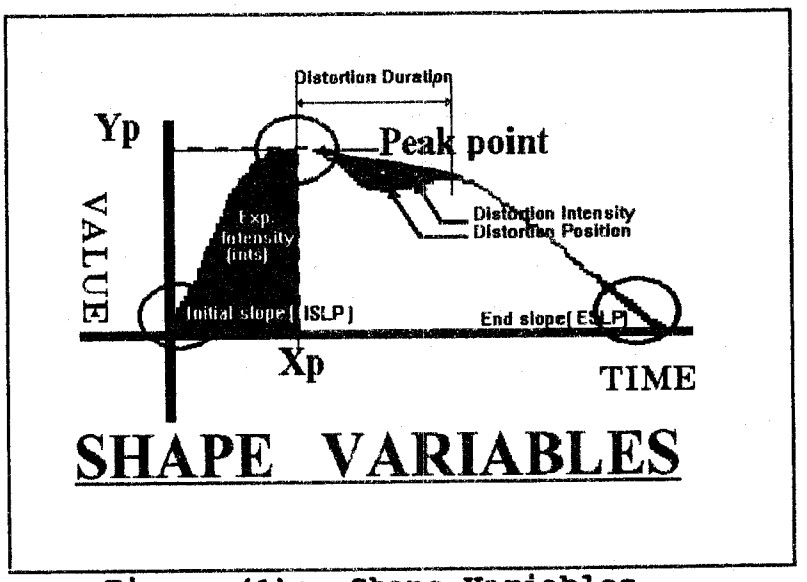


Figure (1): Shape Variables

Once these variables are estimated the mathematical expression will generate the forecast. In TASC, the shape variables can be estimated in two different modes.

Automatic Mode

In the Automatic mode the shape variables are estimated from 78 models built in TASC. These models are the product of over 21000 statistical analysis of a large quantity of data. In this mode, the user is required to define the project in terms of the following variables.

Project Type: There are 21 types of project to select from eg, school, library, land and court.
Project Sub-type: Three subs for each project type eg, primary, middle or secondary schools.
Project Operation: Four groups under alteration, extension refurb, and new construction.
Project Form: consisting of six options including standard, Victorian and purpose built.
Project Scope: Consisting of six options including multiple, one off and shell.
Structural properties: Vertical and horizontal load bearing components eg, concrete and brick
Price Fluctuation Adjustment: Fixed, traditional, or adjusted(NEDO).
Ground Condition: Consisting of good, fair and poor.
Building Hight: Low, medium and high.
Access Within the Site: In horizontal and vertical directions being good, fair and poor.
Buildability: Consisting of simple or complex.

Also, there are fourteen types of event, which can cause distortion on the expenditure profile, incorporated for selection. These include access to site, and keeping occupation. The Automatic mode also utilises its database to recommend project total sum and total duration.

Manual Mode

The alternative, or complementary, to the Automatic mode is the Manual mode which takes a totally different approach to estimating the shape variables. Unlike the Automatic mode, the Manual mode requires a degree of experience and knowledge about the project. The manual mode can be used in two ways.

Direct Manual Mode

In this mode, the shape variables are identified directly. Here, since the user is in the driving seat, a great deal of experience, as well as knowledge about the project, is essential.

Approximate Barchart Manual Mode

This option of the manual mode requires construction of a barchart from which the shape variables are calculated. The barchart can be approximate or it can be detailed. However, TASC is no replacement for project management systems, and it should be able to generate a forecast with minimum information. The barchart is constructed by, initially, creating the shell consisting of activity main heading and activity sub heading titles. The shell is then filled with values relating to the Starting point, Duration and Cost of the activities.

Once the barchart is complete, the twenty stage processing commence, leading to the calculation of the Shape and Distortion variables.

Project Parameters

There are a number of parameters which characterise a construction project. Some of these parameters are briefly described below.

Profit Margin: It is specified, by the contractor, as a percentage of periodic expenditure.
The user: TASC has been designed for use by both the contractor and the client.
Retention: Defined in terms of its variables - percentage release and defect liability period.
Interval Between Payments: The interval, in days, between the successive payments.
First Payment Interval: Number of days before the first payment is received.
Front End Loading: Defined in terms of starting point, duration and intensity of loading.
Christmas Break: To simulate the effect of Christmas break on the cash flow.
Interest Gain/Charge: Interest gained and lost towards investment and borrowing, for positive and negative cash respectively.

Distortions

Research has revealed that the periodic pattern of expenditure often contains multi-modality. These are referred to as distortions. A distortion can be due to the nature of the project, or it can be the product of an external event such as inclement weather. The variables defining a distortion are the position where its effect is maximum, the duration, and the value intensity of distortion. TASC facilitates simulation of up to nine distortions.

Cost Entry

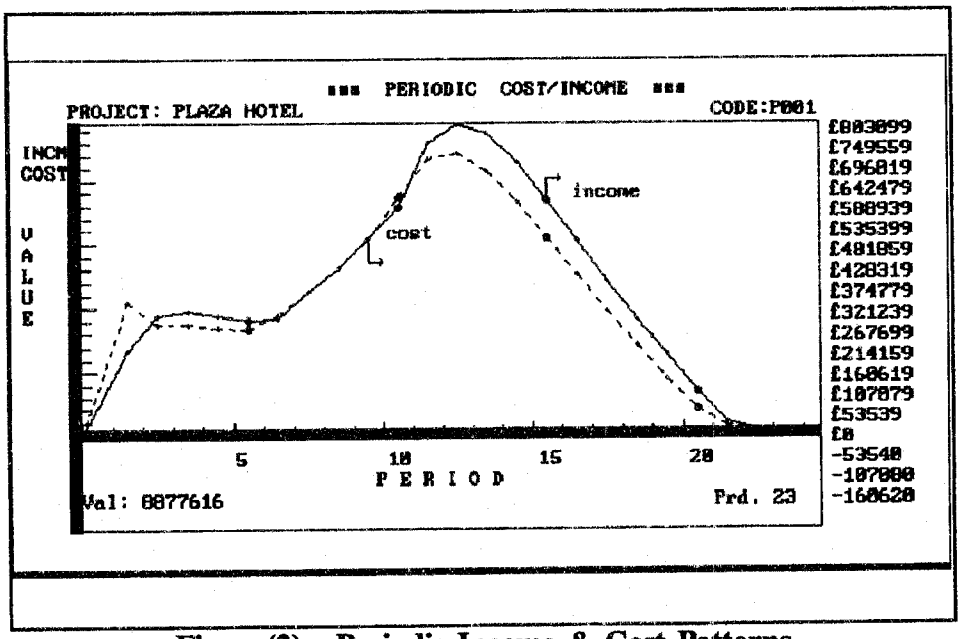
Contractor's cost can take various forms. There are three methods of cost entry in TASC.

Profit-based: Based on the profit margin, the cost is calculated from the forecasted income.
Phased: This is similar to the profit-based, however, the given portion of the cost is paid (*eg*, to sub-contractor) with up to two periods delay.
Direct input: The cost figures are entered directly for cases where no formulated relationship exists between the income and the cost.

Financial Reports

Income & Expenditure

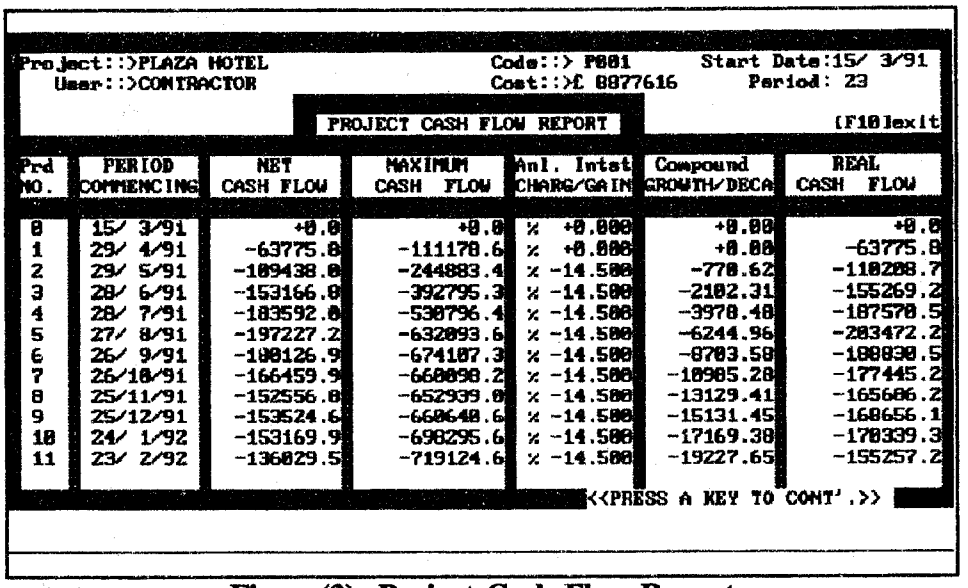
As shown in figure(2) the flow of periodic cost, profit, retention, value less retention, in periodic and cumulative forms, and cash flow for each period are displayed.



Figure(2): Periodic Income & Cost Patterns

The Cash Flow Report

The Net, Maximum, and Real cash flows are listed and shown in figures(3) & (4). The real cash flow also encompasses the growth and decay of positive and negative cash respectively.



Project::>PLAZA HOTEL Code::> P001 Start Date:15/ 3/91
User::>CONTRACTOR Cost::>£ 8877616 Period: 23

PROJECT CASH FLOW REPORT (F10)exit

Prd NO.	PERIOD COMMENCING	NET CASH FLOW	MAXIMUM CASH FLOW	Anl. Intst CHARG/GAIN	Compound GROWTH/DECA	REAL CASH FLOW
0	15/ 3/91	+0.0	+0.0	% +0.000	+0.00	+0.0
1	29/ 4/91	-63775.8	-111178.6	% +0.000	+0.00	-63775.8
2	29/ 5/91	-109438.0	-244883.4	% -14.500	-778.62	-110208.7
3	28/ 6/91	-153166.0	-392795.3	% -14.500	-2102.31	-155269.2
4	28/ 7/91	-183592.0	-530796.4	% -14.500	-3978.48	-187570.5
5	27/ 8/91	-197227.2	-632093.6	% -14.500	-6244.96	-203472.2
6	26/ 9/91	-180126.9	-674107.3	% -14.500	-8703.58	-188830.5
7	26/10/91	-166459.9	-660898.2	% -14.500	-10985.28	-177445.2
8	25/11/91	-152556.8	-652939.0	% -14.500	-13129.41	-165686.2
9	25/12/91	-153524.6	-660648.6	% -14.500	-15131.45	-168656.1
10	24/ 1/92	-153169.9	-698295.6	% -14.500	-17169.38	-170339.3
11	23/ 2/92	-136029.5	-719124.6	% -14.500	-19227.65	-155257.2

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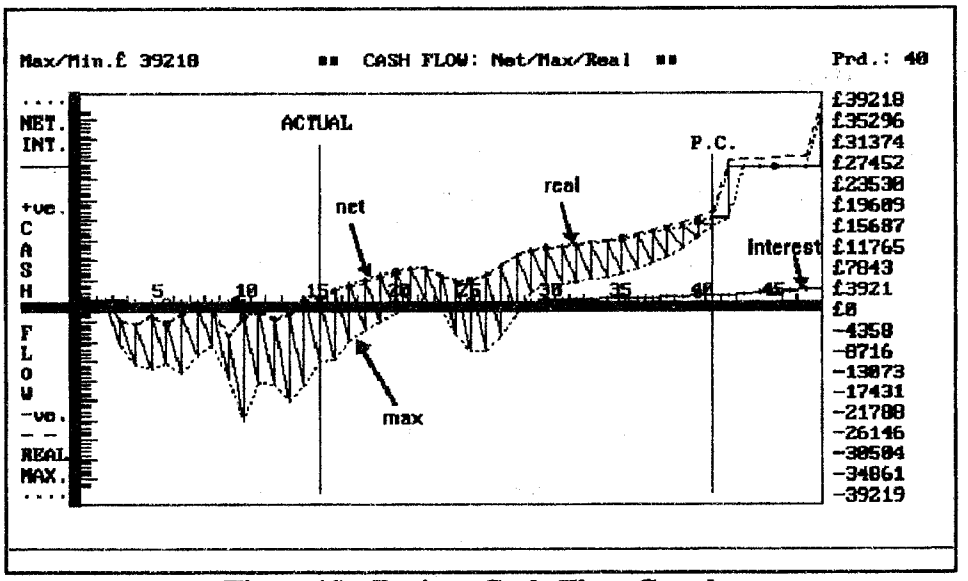
Figure(3): Project Cash Flow Report

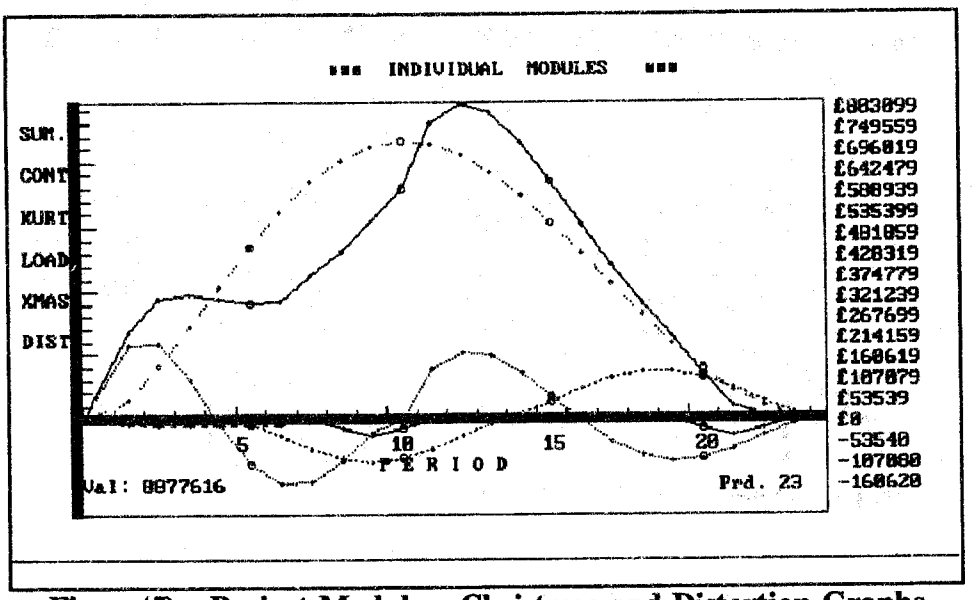


Figure(4): Project Cash Flow Graphs

Modular Break Down

The mathematical expression which generates the forecast of income consists of three modules together with the front end loading and Christmas components. These are shown in figure(5). The modules are:

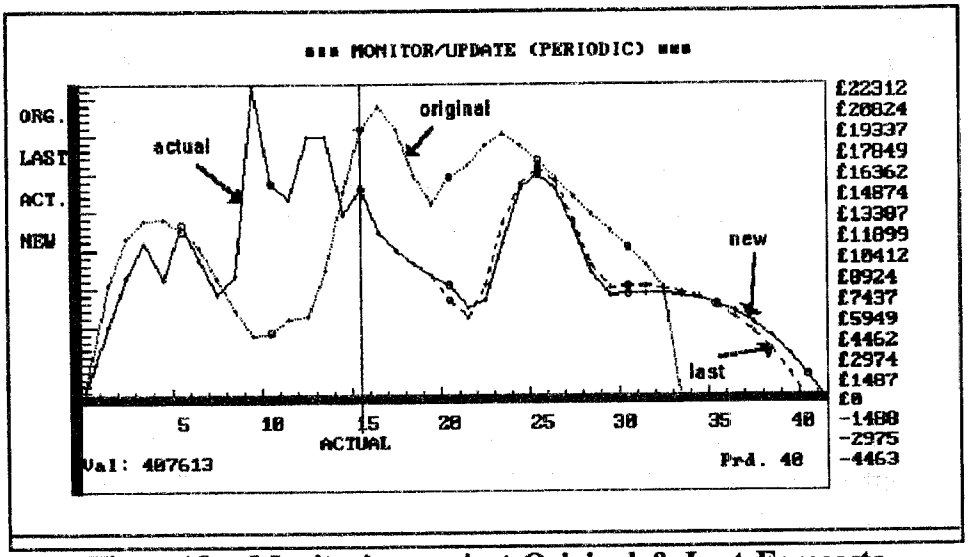
Control Module: simulating the overall pattern.
Slope Module: responsible for the initial and end slopes and expenditure intensity.
Distortion Module: simulating distortions.



Figure(5): Project Modular, Christmas and Distortion Graphs

Control/Update Monitor

With the project in progress, the actual values can be entered at an arbitrary and/or regular intervals. At each update a new forecast is produced, projected from 'time now' to the end of the project. TASC facilitates monitoring and comparing the actual figures with those generated during the very first (original) and the very last forecasts. An example is shown in figure(6).



Figure(6): Monitoring against Original & Last Forecasts

TASC AS A TOOL FOR DETERMINISTIC MANAGEMENT DECISION MAKING

The traditional approach to mobilisation, according to what has been anticipated to happen, is a fatalistic outlook and can be very restricting. Rather, attempts can be made to massage the perceived reality, to as much as realistically possible, in the desired direction. This does not make the forecasting models redundant. On the contrary, it imposes additional demands on them, one which would assist the management to accommodate the project as part of company's corporate plan.

For example, there are times when, in order to maintain its current market share or to expand into other areas, the company is prepared or forced to operate on a very low profit margin. However, in the light of other commitments, this may not be financially feasible. In view of the corporate financial position, the choice to abandon the tender/project, though disappointing, may be imperative. The alternative, however, requires adjustment of the financial profile of the project. But the measures ought to be objective and based on what can be realistically achieved. To this end, the forecasting model can be instrumental in identifying the areas where attention can be focused.

In this section, TASC is used as a model-example which facilitates implementation of deterministic management decision making. Since there are as many possibilities as there are projects and managers, hence, only one scenario will be considered and the discussion will be limited to examination of some parameters. This undertaking, initially, requires the identification of the aim of the intervention. Here are some questions:

Profitability: For the given parameters (eg, profit margin and interest rates), will the project produce profit? If not, can it be converted into a profitable project, or to what extent project profit can be compromised in favour of corporate objectives such as retaining market share?

Funding: In conjunction with other projects and commitments, can the project be funded? If not, to what extent and at which stages should the cash flow be massaged before it is considered as being viable.

Corporate Objectives: Company objectives may require the project to fall on to a predetermined pattern. Can this be achieved?

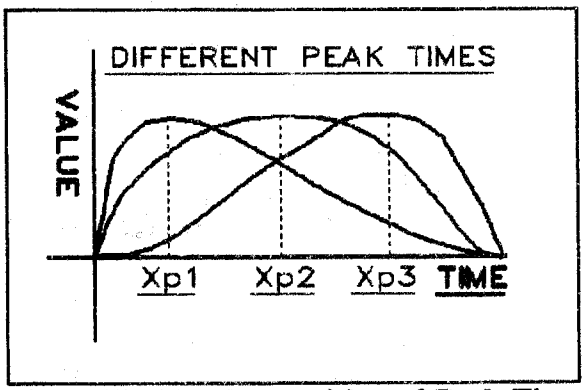
In view of the nature of the identified aim, TASC can be utilised to simulate various scenarios and highlight their outcome on the cash flow profile. This can be accomplished at two levels. The shape variables cater for global definition of expenditure/income profile, whereas, project parameters facilitate simulation of the outcome of alternative specific events.

Shape Variables

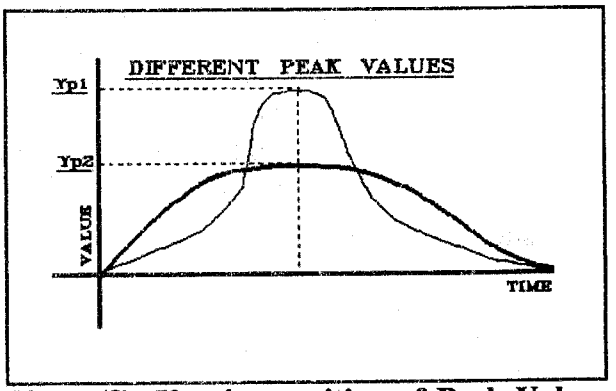
An experienced user, one who is familiar with the project and has an insight into the anatomy of expenditure profile, can exert a direct control through manipulation of the shape variables. The shape variables estimated through the Automatic mode, reflect what is expected to take place. This paths the way for management intervention for simulation of what is required to happen. This is carried out through manipulation of the following variables.

Peak Time (Xp)
This variable controls the peak point along project duration where, the highest payment is to incur, rate of change of expenditure reaches zero and the deceleration process commences. As shown in figure(7), the earlier this point is reached the more secure cash flow will be.

Peak Value (Yp)
This variable identifies the highest single payment, by the client to the contractor, taking place naturally. Figure(8) shows that the greater the value of Yp, the greater the concentration of capital will be around where the peak time is.



Figure(7): Varying position of Peak Time



Figure(8): Varying position of Peak Value

Expenditure Intensity
There is a close association between this variable and peak time. The contractor can influence the cash flow profile by controlling the intensity of the capital concentration in the first (up to the peak time) and second (from peak time to end) parts of the project.

Initial Slope & End Slope
These variables facilitate refinement of the control over the behaviour of the expenditure/income at the very early and very last periods of the project. The high capital engagement for acquisition of a certain plant at the beginning of the project and the finishes at the end are examples where the slope variables can be used.

Project Parameters

These are the parameters which can be manipulated to produce different cash flows. Some are discussed below.

Break Even Profit Margin

The break even profit margin, calculated by TASC, can provide valuable information for the contractor to gain an edge in assessing the viability and profitability of the project.

First and Subsequent Payment Intervals (client to contractor)

The payment intervals can take various forms such as phase handover, stage payment, continuous handover and the traditional monthly payment method. Particularly, the first payment interval has an appreciable influence on project cash flow profile. For a given project, this variable alone can convert a non-feasible project into a feasible one.

Contractor's Cost

Cost is an important component of cash flow. The three methods of cost entry described earlier can produce a substantially different cash flow profiles. However, the contractor can not voluntarily specify its cost pattern. A great deal of arrangements and negotiation is required before a somewhat desirable method of cost payment is adopted. TASC can be used to simulate the effect of various cost entry methods.

Distortion

A distortion can be Anticipative such as inclement weather, anticipated in advance through meteorological investigation. Or, it can be Implementive, involving management intervention. The characteristic feature of the anticipative distortion is that it relates to the nature of the project and its environment. It requires investigation and reference to past. Its objective is to identify and simulate the realities of the project (*ie,* what is expected). Whereas, the implementive distortion represents management decision, relies on user-intuition and experience, and its objective is to simulate the desired state (*ie,* what should be).

Interest Rate/Gain

No matter how deterministic the management is, one variable which can not be controlled single handed is the rate of interest. But management can consider the opportunity cost of various alternatives, such as bank interest versus investments opportunities.

Project Programme

The financial progress of project goes hand in hand with its operational progress. Cash flow profile is highly influenced by the way activities are spread over the project duration and the value contribution of each activity. The many possibilities of project programming can be exploited in aid of cash flow management.

Front End Loading

Here, front end loading has been viewed interchangeably with over/under measurement. Positive loading improves the cash flow. Negative loading can generate income for the contractor through fluctuation adjustment during high inflationary times ahead.

Retention

The impact of retention on the cash flow is appreciable. The retention variables are basically standard, but now days any variable is up for negotiation.

Start Date

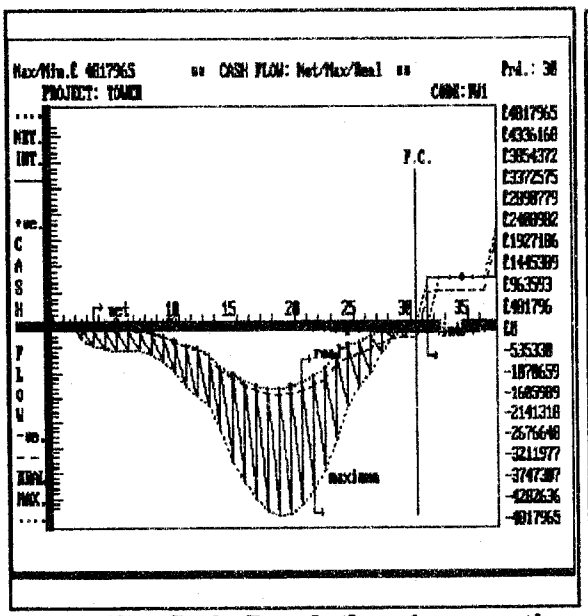
Any change in project starting date will have an effect on both project and corporate cash flow profiles. An example of the former is the anticipation of the weather condition and its incorporation into the forecast.

Management Intervention

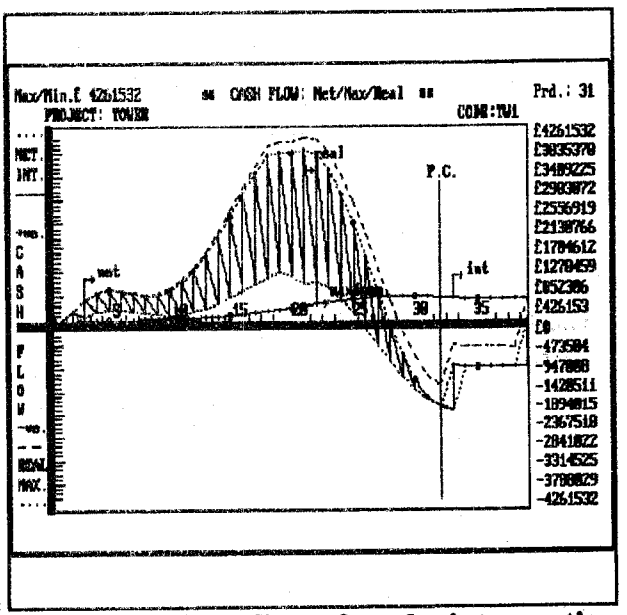
An example of the effect of management intervention, through project parameters, on project cash flow is shown in figure(9) and figure(10), for before and after an intervention respectively. The parameters are listed in table(2).

Intervene	*Profit %*	*Start Date*	*Interest chge gain*		*Cost % Delay Prd*		*Pay. Ist*	*Intv. subs.*	*Xp*	*Yp*	*Slopes ini end*	*Intensity*
BEFORE	5	1/12/93	12	15	100	0	45	60	60	7.5	1.87 .07	56
AFTER	0	1/07/93	12	15	60	2	15	30	60	7.5	1.87 .07	56

Table(2): Some project parameters before and after management intervention



Figure(9): Cash flow before intervention



Figure(10): Cash flow after the intervention

FURTHER DISCUSSION

The utilisation of forecasting models for deterministic decision making can have broader implications and exert influence on the other aspects of the organisation. This can eventually foster development of a new company culture and structure. Examples are discussed here.

(a) The potential benefit from the control over the timing of cost can encourage the company to review its sub-contracting policy. Such an undertaking requires elaborate relationship and communication with the sub-contractor.

(b) The demand by the management for an alternative course of action may not appeal to the decision makers at other levels. Therefore, for such decisions to be realistic and practical, the involvement of the pertinent expertise within the organisation becomes imperative. For example, for the planner to comply and contribute to the requested alterations, s/he should be aware of the nature and reasons of these undertakings. The same applies to the other expertise such as the contract manager and project manager. The proposed approach helps company's objectives to become the focusing point leading to increased global awareness.

(c) The discrepancies between the planned and the actual progress need to be investigated and remedied within the context of the recommended approach. The resulting increased chance of diversion from the 'norm', demands a more efficient and flexible monitoring and control. This requires improved communication and a better awareness of the activities on site.

CONCLUSION

There is much demand on the management of the 1990's to recognise the need for dynamism and creativity. This includes a better utilisation of cash flow forecasting models. Too often, management's aspirations and styles have been hampered by over reliance on the generated forecast, on the one hand, and undermining the potential of the model as an instrument for decision implementation, on the other.

In this paper, the role of cash flow forecasting models within the context of the above notion was examined, and TASC was introduced as a dynamic mathematically-based model which facilitates management intervention. It allows the management to, as realistically as possible, massage project cash flow in order to make it compatible with the corporate objectives.

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